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ABSTRACT

The common theme linking the contributions to this volume concerns the future of universal telecommunications service. The goal of having a universal telecommunications service has historically been to keep charges low enough that all but the poorest Americans could afford to make and receive telephone calls, even if they lived in remote and expensive areas. For decades this goal was neither complicated nor controversial; this is now changing rapidly and profoundly. The essays in this volume explore and illuminate the implications. Following the "Foreword" (Gerry Butters) and "Introduction" (Robert M. Entman), the following papers are included: "Private Networks and Public Objectives" (Eli M. Noam); "What About Privacy in Universal Telephone Service?" (Daniel Brenner); "Technologies of Universal Service" (Susan G. Hadden); "Universal Service and NREN" (Barbara O' Connor); "Toward a Universal Definition of Universal Service" (Herbert S. Dordick); and "The Globalization of Universal Telecommunications Services" (Joseph N. Pelton). (JLB)

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1991

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UNIVERSAL TELEPHONE SERVICE

Ready for the 21st Century?

1991

Annual Review of the
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FOREWORD

Progression through the rapid advances of the Information Age requires a new discipline—*systemic thinking*. According to Peter Senge of the Sloan School of Management at MIT, "Systems thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace."

Given the existing capability to gather and analyze massive amounts of information, and then disseminate it in a way that transcends time and space, decisions can no longer safely be made in a vacuum. Each decision transmits its impact throughout the system—sometimes blocking any systemic progress. The key to obtaining the desired outcome of a decision is to discover the leverage points in the basic system that when pressured can create huge alterations in the system structure. Once recognized, manipulation of those leverage points can guide us toward the desired unified whole.

As the United States considers the development of a national information communications infrastructure, we should look at the issues and potential systemically. The future opportunities that a nationwide high-speed network offers seem unsurpassed in mankind's history. The challenges are of equal magnitude.

The great ideas and discoveries that have moved the world forward on its progressive path have been the result of the collaboration of creative minds. Michael Schrange, in his book *Shared Minds*, gives us many illustrations of this, from the invention of the telephone to the discovery of DNA. And with the increased complexity of today, the

sharing of great minds is ever more important to continue progress. One of the major opportunities of a national, or perhaps international, communications infrastructure is the potential for that collaboration. It can enable scientists, doctors, artists, and teachers to communicate effectively with each other—even electronically, sharing the powerful capabilities of super computers working on unique projects and research across the globe.

Another opportunity that may be provided is the expansion of life services into previously remote areas. Physicians at medical facilities hundreds of miles away may be able to monitor a home-bound patient. Similarly, creative teaching methods and individualized programs may become available to students no matter where they live.

The question then becomes, Who will have access to such opportunities? When will such capabilities become generally available to provide such services to the total populace? In the United States particularly, universal service—the general availability of the telephone as a primary communications tool—is considered almost an inalienable right. As such, its enhancement to include the greatly expanded information services promised by the planned new infrastructure poses some sizeable challenges.

In his book *The Work of Nations*, Robert Reich describes the sobering prospect of the continual separation of the "symbolic analysts"—those educated persons who work with information to identify and solve problems—from the rest of the population. He clearly depicts the dire social consequences that may occur if the information "haves" leave the "have-nots" even further behind. Universal service could be one means of re-integrating society, of achieving a greater equality of condition and opportunity by making information generally available through universal access.

But what about the questions around access? Access to what? Who will determine what information is to be made generally accessible? Who decides who gets access? Does the use of access or the information itself need to be guarded? If so, by whom?

A challenge that is equally formidable is how to make access available relatively simultaneously to all. Adoption of universal service questions a pure market view of proliferation of service to early adopters and then to the general populace since, in this case, the physical ability to connect to the infrastructure is required before adoption is

possible. Service must be able to reach all geographic areas if it is to be universally offered.

These are some of the issues raised by the authors represented here. The objective of this volume is in concert with the objective of the Institute for Information Studies—a combined effort of Northern Telecom Inc. and The Aspen Institute—to explore the issues of the Information Age and its technologies from a variety of perspectives to generate insight among leaders. It is insightful leaders who will forge the paths into the future and manage the impacts of change.

Information is the change agent and, simultaneously, the key to providing the direction for change. This volume strives to be one more source of that key element—information.

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INTRODUCTION

THE FUTURE OF UNIVERSAL SERVICE IN TELECOMMUNICATIONS

The common theme linking the contributions to this year's *Review* concerns the future of "universal service." The goal of having a "universal" telecommunications service has historically been to keep charges low enough that all but the poorest Americans could afford to make and receive telephone calls, even if they lived in remote, expensive-to-serve areas. For decades this goal was neither complicated nor controversial. Telephone service was pretty much the same for rich and poor, business and residence alike: You picked up the phone, dialed, and talked. And the cost of keeping prices down could be disguised via internal subsidies generated by the regulated monopolies that provided the service. This placid scenario is changing now, rapidly and profoundly. The essays in this volume explore and illuminate the implications.

All told, the essays suggest a vision that is at once optimistic and troubling. On the positive side, revolutionary improvements in telecommunications and information technologies are proliferating. They are almost certain to become global in scope, resulting in many improvements in human knowledge and productivity; a substantial increase in the functional intelligence of the species seems imminent. Yet there are also reasons to fear that these advances might be enjoyed by only a small segment of the U.S. or world population. Even if Americans reach a consensus to devote substantial resources to achieving some level of equality in access to advanced telecommunications, daunting quandaries will have to be confronted, obstacles surmounted.

Central to the dilemma is that competition, deregulation, and privatization have been integral to the rapid spread of technical innovation in recent years, yet these very same forces threaten our ability to

implement universal service the way we have in the past. The flourishing competitive market is now creating the opportunity to upgrade universal service even as it may be undermining our ability to employ traditional policy and conceptual tools to implement the upgrade. As all the authors suggest in one fashion or another, decisions on the nature of universal service in the future cannot be left strictly to market forces, but neither can we rely on proven government tools. Innovative policy decisions will be required to avoid an outcome that in the worst case would entail a highly developed series of private networks poorly integrated with an undernourished public network that provides few advanced services, and those to only a small minority of Americans.

The capabilities that an advanced public network is likely to offer—which could become part of a basic package to be more or less universally accessible—include: telephone numbers attached to individuals not locations, along with portable phone sets; services that (at least currently) require wide bandwidth such as motion video; a personal computer terminal providing processing power internally or via the telecommunications network; information services that offer large stores of easily retrieved data, such as airline schedules, news bulletins, classified ads, or stock quotations; transaction services that allow anything from banking and shopping at home to telecommuting; and convenience services such as call waiting, caller identification, and call forwarding. The proximate questions revolve around how many of these options should become part of the universal service goal, in what form, at what cost—and at whose. The deeper questions involve the nature of the society's commitment to equality.

In telecommunications as in other policy areas, there tends to be some tension between efficiency and equality; market competition is unsurpassed at bringing about the former, but sometimes the latter suffers. At its core universal service has been designed to achieve an approximation of equality; when everyone sought plain old telephone service (POTS), and that was pretty much all the telephone company could provide, equality was a relatively simple goal. With a vastly expanded menu of telecommunications product and service options, equality becomes a more amorphous aim. Among those likely to be affected by any future universal service policies there will be varied tastes and needs; policy makers may want to support a substantial range of choice for targeted consumers. In practice, "equality" will no longer

translate into likeness. Figuring out what set of functions or services should be encompassed by universal service goals, how much should be invested in reaching the goals, and how that amount should be financed, will pose a much more demanding task for government officials than administering the old universal service policy.

The recent direction of public policy toward minimizing government intervention and maximizing reliance upon competitive markets may conflict with the need for explicit planning that universal service issues appear to impose on government. The record of the past decade—for instance, Congress's attempts to rewrite the 1934 Communications Act to accommodate explosive changes in technology and market structure—unfortunately suggests that political gamesmanship as much as careful analysis may shape any policies that are finally adopted.

However, at least some of the authors suggest that the apparent tension between the economic efficiency goals that animate increased reliance on competition, and the equality goals that have animated universal service, may be less severe than often assumed. They indicate that policy assuring a relatively high level of minimum universal service will yield considerable net economic benefits. In this view, even if such benefits are not realized by telecommunications firms, they will accrue as gains in efficiency to the society at large. For example, Susan G. Hadden cites possible economies that telecommunications might provide in treating illness; because the nation's medical bill is so large, even saving a tiny percentage could translate into many billions of dollars saved. The authors also adduce strong arguments for such a policy on the grounds of equity, enhancement of democracy, and other values.

But it is fair to say that several of the authors exhibit a bias, perhaps not surprisingly, given that they have been drawn to the study of this field. Their essays suggest they are deeply inspired by the exciting capabilities and potential of advanced telecommunications to do social good; this may predispose them toward expansive and expensive visions of universal service. I share the bias myself, and would vigorously defend it. But analysts not represented here might have argued for a much more limited vision of universal service, a much less intensive role for government, and a less expensive agenda for subsidy.

The issues that arise as society grapples with modifying universal service in light of technological advance turn out to raise profound conceptual and ethical complexities not heretofore familiar to policy

makers in telecommunications. When viewed in a universal service perspective, certain traditional assumptions break down, old concepts and definitions become problematic. It will be politically difficult to seek subsidies that may as easily be used for accessing *Debbie Does Dallas* or the latest Superbowl odds from Vegas as for viewing *Henry V* or *The New York Times*, but this conundrum typifies the issues raised by the need to modernize universal service. That is, thinking through what we as a society mean by *universal service* in an era of changing telecommunications capabilities involves dealing with such issues as what is important information and what isn't, what is "information" at all and what isn't, how much an "informed society" is worth, how much inequality in access to information is tolerable, and what right subsidizers have to determine the nature of information accessed. Here are some more specific examples inspired by the chapters you are about to read:

- Is the distinction between information and entertainment still viable? Should universal service encompass access to video services, including "entertainment," if telecommunications becomes the major vehicle by which both high and low culture is accessed? Can we be sure that vehicles labeled as entertainment, such as films or television situation comedies, are in fact less informative and thus less socially desirable than newspapers? That rock music videos are less edifying than classical ballets? Even if we want to limit subsidies to informative or uplifting fare, will it even be practical to enforce distinctions once both are delivered digitally over telecommunications networks?

- Consumers and workers will be producing intricate, detailed data bases on themselves as they access telecommunications services. People who need subsidies in order to access services may well have to endure intrusive probes of their personal tastes, habits, and resources in return for the subsidy. What will be a fair level of inquiry, and when will a legitimate effort to ensure proper use of subsidies become an invasion of privacy?

- Are our very notions of "news" and "public opinion" going to need thorough revision once a majority of people obtain a customized daily mix of text and motion video designed according to each

person's specific stored instructions? If old-fashioned print newspapers and television network news cannot survive the competition, will government, by subsidizing public access to an advanced telecommunications infrastructure, be helping to destroy "mass" media? Is such an intervention compatible with the First Amendment? And if mass media are replaced by customized news, if similar media reports no longer reach the vast majority of citizens, will government be subsidizing a diminution in the society's cultural glue, and in the ability of political leaders reliably to communicate with the public?

- What rights do the advanced, mostly Northern Hemisphere nations have to build a telecommunications infrastructure that leaves less developed national economies even further behind than they are already? What moral obligations for international subsidies are entailed here? What self-interests? Addressing these problems may require cooperation among private entities and governments on a global scale, of a sort for which history suggests few precedents.

While the articles that follow stimulate a diversity of questions, they develop some common themes. A few of the ideas endorsed by several though not necessarily all the authors:

1. We can expect a continuation of rapid technological progress in the form of lower costs for computing power, transmission bandwidth, and speed. Thus in the absence of public policy to the contrary, state-of-the-art telecommunications capabilities could grow increasingly distant from the traditional voice service used by most ordinary residences and small businesses.

2. There will be a need for active government involvement even as competition, deregulation, and privatization of much of the telecommunications network proceeds. Universal service cannot be a matter for laissez-faire evolution; explicit decisions will have to be made. If they are not, if government allows telecommunications to develop without an overt plan for upgrading universal service, such an approach will itself amount to an implicit decision to allow the level of service offered as "universal" to deteriorate drastically relative to the state of the art.

3. Among the most nettlesome difficulties that may get in the way of attaining a higher "universal" level of service are those involving the setting and enforcement of standards designed to protect interconnectivity. The problem is magnified not only by competition and proliferation of services and firms but by the globalization of telecommunications. A plethora of incompatible equipment, networks, and services will present considerable difficulties to even the wealthiest and savviest customers seeking seamless, user-friendly access from private networks; forging some kind of coherent public network is a prerequisite to an advanced version of universal service designed to reach the average person.

4. Despite these issues, most of the authors appear to expect that an integrated, multi-media-capable, digital, broad(er)-band public network will arise. The degree to which it will be easily, inexpensively, and frequently accessed by small business and residential consumers is less clear.

5. Telecommunications networks are becoming global, which is challenging national boundaries as well as changing the nature of economic markets. There is some question about how governmental authority can be exerted over telecommunications networks, firms, markets, or services that reach across national jurisdictions.

6. Implicitly or explicitly, most authors endorse spending considerable amounts of money on upgrading universal service so that most Americans can participate at a reasonably high level in the information age. None seem to accept limiting universal service merely to POTS.

Let us turn now to a preview of the individual contributions to this issue of *The Annual Review*.

The Privatization of Telecommunications

Perhaps the development of highest relevance to universal service is the channeling of a substantial portion of the nation's total telecommunications investment into private networks. Eli M. Noam's article explores this trend and its implications, raising dozens of important

questions that already confront policy makers and other decision makers, or soon will. Most importantly, Noam argues, increasing private control over networks may paradoxically lead to increasing restrictions on the rights of individual network users.

Noam documents the rapid development of private and closed-user-group networks—one-third of all investment in telecommunications networks now goes outside the public network. He points out that these configurations involve not just internal corporate links, but group networks such as those connecting financial institutions for electronic funds transfer, or the one joining General Motors to its many suppliers, dealers, and insurers. In the future, Noam says, the telecommunications system will consist of a "federation" of such private networks, "linked through a modular public network."

Privatization is driven by a number of forces, including the expansion of the service-based economy with firms needing more specialized communications services, and the economics of public networks, which at a certain point cost large users more to support than do private networks. Noam even sees the logic of privatization extending to individuals, such that "personal networks" may arise. These would employ virtual private networks that actually use shared facilities but are dedicated via software and hardware settings to a particular individual's service and information needs.

Among the many implications of proliferating private networks that Noam probes, perhaps the most provocative involves his prediction that networks could develop quasi-governmental powers and status. They could become a form of electronic neighborhood or community joining users without regard to geographical proximity. Those who control policy for the networks would be able to enforce regulations and taxes on members, and they would negotiate with other jurisdictions, including not just other networks but official government entities like Europe's Post Telegraph & Telephone or the U.S. Federal Communications Commission. In such a world, for example, it may become more difficult to tax telecommunications activities, or to police illegal economic activity like collusion.

But of greatest concern to Noam is that these quasi-governmental authorities may have the incentives and the capacity to enforce limitations on the expressive rights of their users. He describes the tension between the individual rights of association that lead inexorably to

private groupings of telecommunications users on private networks, and the individual rights of those users to express themselves on networks that are not operating under common carrier obligations. He describes restrictions that a network operator might impose, for example, on those who might wish to use it to transmit unpopular views. This problem is magnified by the likelihood that networks will be multinational in scope; this vision implies that "the First Amendment may become little more than a 'local ordinance,' and in conflict with the speech principles of other countries." Even within the United States, it is not clear what is paramount, the constitutional rights of networks which could assert a status akin to publishers, or the rights of its users or potential users.

Noam suggests creating "a set of principles to guide interconnection in a mixed private-public network system." He proposes granting "rights-of-way" to traverse private networks in order to maximize individuals' choice among telecommunications networks and services, and prevent people from becoming captives of private networks that could exert oppressive powers. In return for allowing private networks to connect with the public system, the former would have to cede such rights of passage, thus allowing for "unimpeded transmission of information across the network federation and enable end to end connectivity. . . ." The chapter raises intriguing questions as to exactly how this confederation would work, and how a minimal level of universal service would be maintained.

The Costs of Privacy

Privatization is not correlated with privacy, despite the similar lexical roots. Daniel Brenner dissects the ways in which technological advances can both improve and diminish privacy protection and can affect the costs of telecommunications service. In Brenner's view, including enhanced privacy protection within a revised universal service should be done with consideration of the substantial financial costs inherent in maintaining many forms of privacy, the conflicts among privacy interests, and the need to allow individuals to choose the level of privacy protection that best suits them.

Brenner defines privacy as twofold: the right to be left alone, and the right to control dissemination of personal information. These two can clash, as demonstrated in recent controversies over caller identification

service which displays the originating number of incoming calls. An analogous contradiction arises between the thrust of universal service, which is to make everyone accessible via the telephone, and the emphasis of privacy, which is to allow people to remain inaccessible.

Resolving such tensions not only is difficult conceptually, but is expensive financially. Since increasing privacy protection is costly, building enhanced privacy safeguards into the public network along with enhanced capabilities could price phone service too high for some to maintain telephone service; in this way, the strain toward privacy could militate against universal service. If, for example, caller-ID were mandated as a privacy enhancement available to all as part of the basic telephone service, it would raise network costs, and presumably monthly charges. For the substantial number of consumers who do not place a high value on protecting themselves from unwanted callers, there would be a particularly unwelcome extra expense.

The other side to privacy, besides being left alone, is controlling dissemination of personal information. In discussing this side of privacy, Brenner introduces the idea that people should have property rights in data about themselves. Thus, he says, if a telephone company sells information about usage patterns of individuals to marketing concerns, it should only be with the permission of subscribers, who should be paid for such commercial use of information about them.

Weighing the conflicting desires that are inherent in considerations of privacy is a prototype of the kinds of difficult decisions officials will have to make in updating universal service policies. Brenner makes the innovative suggestion of providing policy makers confronting these issues with periodic checks of public expectations and preferences in this area via a regular series of opinion surveys. It might not be a bad idea to extend the ambit of the survey to include not just privacy but public thinking on some of the other issues raised in this volume.

The Need for Government to Decide

Susan Hadden's theme is that the U.S. government must make an explicit policy choice as to what vision it wants of universal service. Technology makes possible a multitude of versions of universal service; the one that is best for American society will not evolve naturally from the aggregation of individual consumer choices, in Hadden's view. Instead, public policy must determine a vision and chart a course.

Hadden's first concern is to establish that telecommunications innovation is different from that in other areas. More or less universal adoption of the television set, for example, could be left largely in individual consumers' hands. Telecommunications is a networked service requiring a highly elaborated infrastructure and offering a broad array of options. In this circumstance, signing up for the innovation requires a combination of individual consumer decisions with a public policy that makes the infrastructure widely accessible.

Hadden sketches four creative scenarios that depict different versions of what a future universal service might look like:

- *The personal telephone:* This example describes how a telephone number would be attached to an individual rather than a place. Everyone would have a number that would go everywhere with them, and a portable phone set that includes a small screen for displaying stored messages; the phone could be plugged into a desktop computer for more sophisticated uses. Voice calling, voice mail, and call forwarding would be part of the universal basic service package.

- *Essential information:* Here the emphasis is on access to a certain minimal level of information "at low or no cost." In this vision all homes, schools, and libraries would receive an information terminal accessing a variety of services, some for a fee and some included in basic service. The terminal would allow interactive audio, video, and data transmissions. Publicly sponsored information services might include posting homework assignments, public event calendars, and tutoring, while services like movies and stock quotes would be available for a fee.

- *The unintelligent network:* This scenario relies upon more intelligent customer premises equipment (CPE) connected to a highly unbundled public network. The CPE would offer a myriad of service options tailored to individual users. Presumably there would be allowances for everyone to purchase some minimal equipment configuration. Hadden criticizes this plan as leaving small users vulnerable to equipment obsolescence and other disadvantages.

- *Targeted services:* This version would emphasize individual tastes being programmed into the telecommunications terminal, such that certain kinds of news and data would be stored for retrieval at convenience and others ignored. Universal assistance would presumably be given to ensure all citizens access to a personalized service package. The problem, alluded to earlier, is that the common social ground provided by existing mass media formats could dissolve. Thus there is "the possibility that such targeted services will actually divide the community rather than integrating it as a universal service should. . . ."

Given these varied though not mutually exclusive options, Hadden argues forcefully for government to make some choices as to where modernization of public telecommunications networks should move. Her own analysis is that, "Even under the strictest standards of modern benefit/cost accounting . . . net social gains will be highest if a relatively high level of interactive telecommunication is available to every member of society."

NREN and the Goal of Educational Improvement

Barbara O'Connor's essay explains and critiques the concept of the National Research and Education Network (NREN). While supportive of the network's ostensible purposes, O'Connor questions whether NREN as presently envisioned can achieve them. She suggests that NREN, if implemented as currently configured, is likely to remain a preserve of elite research institutions. O'Connor fears that NREN will do little to augment the efficiency and effectiveness of teaching and learning in most institutions of elementary, secondary, and higher learning. Nor does she believe it will reach most individuals, and in this sense will fail to facilitate universal service goals.

The NREN proposal is part of the High Performance Computing Act of 1991 (S.272). The stated goal is "to enhance national competitiveness and productivity through a high speed, high quality telecommunications network infrastructure which would support a broad set of applications and network services for the research and instructional community." The chief Senate sponsor, Albert Gore (D-TN), proposes to spend about $200 million annually over five years to build NREN; President Bush recommends $149 million for the next budget. But the

highlight of NREN is its carrying capacity: It would be able to transmit data at 3 billion bits per second—enough to send the *Encyclopedia Britannica* in one second.

O'Connor's argument is that this is a fine achievement, but that in its current form NREN "creates a real potential for information haves and information have-nots." She believes the "E" in NREN, the educational goals, are unlikely to be met, since it would connect only the largest research institutions; the modest funding levels proposed could not possibly support the extension of NREN to K-12 schools. She notes that "There's no plan or provision for a technical hookup of K-12 schools or local libraries . . . let alone any of the training, customer premise hardware or courseware necessary to make technology infusion effective in a K-12 environment."

O'Connor intimates another subtle, deleterious potential of NREN. Concentrating hopes and resources in NREN may distract the public and government decision makers from the more expensive and complicated task of harnessing advanced communication technology for the country's elementary and secondary educational system. More broadly still, suggests O'Connor, the NREN could serve largely as a misleading symbol. NREN implies a coherent governmental attempt to harness communication technology to enhance education, augment the competitiveness of the workforce, and diminish the threat that a large class of "information have-nots" might arise. But in truth, suggests O'Connor, NREN would do little to serve either educational goals (aside from aiding high-level researchers) or the traditional aims of universal service.

Preventing an "Information Underclass"

Among all the authors, Herbert S. Dordick presents perhaps the most explicit endorsement of maintaining equality while upgrading telecommunications. He urges that universal service be revised quite dramatically to take account of new capabilities, including not only guaranteeing access to information services in order to avoid development of an "information underclass," but also what he calls "discretionary services," such as call waiting. The latter services may be highly valuable to poor persons, yet relatively inexpensive to provide.

Dordick discusses the substantial achievement of universal service to this point: 93.3 percent of households have telephone service,

which actually represents an increase since 1983, despite imposition of subscriber line charges and higher monthly rates. As this experience suggests, the price elasticity of demand for telephone service is extremely low; that is to say, people value their telephones very highly. In the future, Dordick suggests, when telecommunications will be offering many more services, this attachment to the telephone can only grow more compelling—hence the need for revising upward our conceptions of universal service. At the same time, nearly 7 million households even now do not have POTS; extending service to them should remain on the agenda.

Dordick catalogs the numerous ways in which advanced telecommunications capabilities are likely to become as integral to life in the near future as POTS is now. He points out that some of the newer services that may be luxuries from a middle-class perspective could be near-necessities to poorer citizens. For example, call waiting can function as a kind of inexpensive party line for multi-family dwellings where not everyone can afford a phone. (It's not clear whether the phone company would like to encourage such cut-rate means of obtaining access lines, of course.) And the importance of ordinary voice service as well as newer information services to such functions as job-seeking, formation of associations, interaction with government agencies, and participation in the democratic process also argue for an expansive conception of universal service.

Funding for this vision should come through the welfare system rather than internal telecommunications subsidies, Dordick suggests. He asserts convincingly that different poor people are likely to desire different packages of telecommunications services, which argues for granting them something akin to telecommunications vouchers. Some might use them for renting terminals that would hook up to information services, others for accessing a video dial tone, others for call waiting and forwarding, but the point would be to prevent the gross social stratification that might otherwise arise in an economy that will be increasingly information-based.

The Barriers to Global Reach

While the tone of Joseph N. Pelton's exploration of globalization in telecommunications is optimistic, his article presents an extensive catalog of practical barriers to global implementation of a high-capacity

network available to ordinary people. Pelton would like to see worldwide interconnection providing universal access to advanced capabilities without regard to national boundaries. But he suggests that the realities of international economic and political relations are likely to make such a vision difficult to achieve.

Pelton believes that there are strong forces working in favor of a global commitment to a universally accessible, advanced telecommunications network. Most important is the likely universal recognition of the vast benefits of such a system, include the productive economies or efficiencies as well as the peace keeping functions of easy global communications.

The will may well be there, but the way is another matter. The impediments are abundant. They include:

- The high investment needed, including the requirement of rapidly depreciating an enormous amount of still-useful embedded plant.
- The lack of demonstrated market support (consumer demand) for the services such a network would offer.
- The possibility that separate networks, optimized for specific uses, would be a more efficient solution.
- Trade barriers and conflicts among nations.
- Conflicting values and investment priorities among nations.
- Incapacities of existing international standards bodies to devise and enforce optimum standards across so many jurisdictions.
- Insufficient incentives among individual firms to cooperate on developing universal interconnectivity.

Pelton recommends development of a broad global consensus on the need to create a universal network, which would feed movements to reform standards-making processes and institutions (especially the International Telecommunications Union), and to get international trade organizations involved in removing restrictions that hinder globalization of telecommunications. He suggests the standards problem is perhaps most vexing, and proposes nothing less than global

planning to allow interconnection of public and private networks, and to create open standards and "agnostic interfaces" that would promote user-friendly universal access. He also urges coordinated efforts to develop an understanding of the potential market for all the new services and opportunities that such a network would promise. In the end, the key need Pelton suggests is enhanced understanding of the potential benefits of telecommunications. Ironically, improved global communication is needed now, before the global network is anything more than a vision, in order to convey that understanding and make the vision a reality.

CONCLUSION

The articles are longer and richer in raising important questions than they are in recommending ways to answer them. That is not surprising. Participants in the telecommunications policy process have barely begun to address the issues; most government officials and ordinary citizens until now have paid little attention to this policy area. The options, costs, and constraints we confront in making these critical policy choices are thus only dimly visible. It is more than enough to have exposed and dissected many of the key issues we will be confronting in the near future, and that is what the following chapters accomplish with depth and clarity.

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PRIVATE NETWORKS AND PUBLIC OBJECTIVES

Eli M. Noam

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In America—and increasingly abroad—electronic highways proliferate, as do the providers of electronic and video information. Electronic networks thus appear well on their way toward openness and freedom.

But are they really? Just because one set of restrictions disappears does not mean that new and perhaps unanticipated bottlenecks will not emerge instead. One such bottleneck is, paradoxically, the result of the exercise of a fundamental freedom: the freedom of association. I will argue that the cumulative impact of this freedom in the telecommunications field may well lead to restrictions in another: the exercise of free speech.

To understand why freedom of association may lead to reduced freedom of speech, we have to understand where the evolution of telecommunications is taking the network environment and the extent of this transformation. This will be the subject of the next several sections.

THE EMERGENCE OF PRIVATE NETWORKS

When discussing developments in telecommunications, one type of privatization receives much attention—the *ownership transfer* of a national network into private hands, for example, British Telecom in the United Kingdom, Telmex in Mexico, and Nippon Telegraph & Telephone in Japan. But there exists another quieter process with much

greater long-term significance that may be called *use* privatization—the rapid development of private and closed-user-group networks. These networks are private, but not necessarily in the sense of ownership. They may be fashioned from state-owned segments, as in the ministry-run networks in the People's Republic of China, or they may be used by the state, as in the case of the U.S. government's giant FTS-2000 system. But they are private in the sense of being separate from the public or general network, and they are not open to all in the way that the public network is. This type of privatization has evolved rapidly; as it grows it calls into question traditional telecommunications arrangements.

An analogy may clarify this shift: Ownership privatization corresponds to a transfer of shares in a state-run railroad to private shareholders; use privatization is comparable to admitting private automobiles and taxis as means of transportation. Arguably, changes in the ownership of the Long Island Railroad or Conrail had only a minor impact on a city like New York, while the evolution of the private automobile had an enormous impact on the cityscape, metropolitan growth patterns, job location, and ethnic stratification.

The trend toward private segmented networking, though largely outside the public view, has been rapid. Most observers still view private networks as essentially special arrangements at the margin of the regular system. But in the future, we may well observe a reversal of what "regular" means. For example, while in 1980 virtually 100 percent of U.S. network investments were made by public network carriers, in 1986 this figure had already dropped to 66 percent; the remainder was accounted for by large users and private networks.[1] Large organizations, such as Citicorp and Boeing, run network operations requiring many hundreds of employees. For Citicorp, telecommunications has become, after personnel and real estate, its third largest expense item.[2] The federal government contracted for its own private network, FTS-2000; valued at $25 billion, it was the largest federal civilian procurement.[3]

Perhaps even more significant than intra-organizational networks are the emerging group-networks. First to develop were clearing networks for financial institutions such as FEDWIRE (payment network), CHIPS (U.S. payment netting system, with counterparts CHAPS–UK and CHATS–Japan), and, internationally, the Society for Worldwide Interbank Financial Transactions (SWIFT), followed by horizontal and

vertical networks for florists, travel agents, insurance companies, and advertising agencies. Next were industry networks linking entities in frequent business contact. General Motors, for example, created a vast system among its own far-flung operations and its suppliers, dealers, insurers, and financial intermediaries, internationally as well as domestically. Such networks provide relatively secure, cheap, and customized communications. They also tend to have service features which go beyond simple transmission, providing "added value" such as electronic data interchange or other software enabling transactions. Similar services are also offered by specialized value-added services networks or enhanced services providers.

The spread of private networks raises new issues—and old issues in new guises. Take as an example the private network of a university such as Columbia. Columbia's proprietary system—in place since September 1988 at a cost of $15 million, requiring the rewiring of the entire campus and employing a workforce of 46—was instituted as a superior communications solution but has drawbacks for the actual users: It severely limits terminal equipment options (only four terminal models are available and compatible); it charges its users prices substantially above costs, with no obvious constraint and no information that can be used to evaluate the justification of charges; it provides only bundled service/equipment packages, with all deviations at a very high cost; it charges very high rates for the connection of modems, codecs, and fax equipment; it can legally refuse service to unpopular political groups as long as it does not discriminate on the basis of race, sex and religion; it can monitor or limit electronic mail messages; and it blocks its employees and students from reaching certain numbers. For the users of the network (as opposed to its operator), there is practically no recourse to regulatory agencies. Thus, the institution may be better off, but its users may not be.

Across the country, and even the world, large institutions and groupings create similar private networks. As this system evolves, it is appropriate and necessary to look at it with increased attention and to analyze the public policy ramifications of its aggregate. In doing so, this paper will describe the telecommunications environment of the future—a federation of private networks linked through a modular public network—and the status of traditional public objectives in such a new system.

THE EMERGENCE OF THE PRIVATE NETWORK SYSTEM

There are several factors that led to the emergence of private networks.

Office Technology Deployment

Private networks began as dedicated voice circuits leased from the telephone company for users who wanted to connect, on a permanent basis, several of their facilities, e.g., a downtown headquarters with a manufacturing plant across town. Soon, however, more complex arrangements evolved. Physical range increased and involved other domestic telephone companies and then international carriers. Organizations also used an internal switching capacity, first by manual switchboards and later by private automatic branch exchanges (PABXs), with functions similar to those of a telephone company switch. Users added increasingly "smart" electronic equipment and interconnected it, especially after the 1968 *Carterfone* decision permitted non-AT&T equipment to be used. It also led to the sharing of circuits by several users interconnecting through a PABX. Carriers, at first resistant, later offered software-driven hybrid services, known as "virtual" private networks, contributing to a blurring of the distinction between the switched public network and non-switched (fixed) dedicated private networks.

Users increasingly gained control over the network segments closest to them; first, over equipment on their premises; second, over the wiring segments in offices and residential buildings. It was natural, as the next step, that several large American landlords began to provide a full array of telecommunications services within their building to commercial tenants, thus taking this segment out of the public network. These "shared-tenant services" shifted the switching from the public exchange to the landlord's private branch exchange (PBX), and moved transmission from the public networks to private lines. The shared services, by their economic logic, expanded to clusters of office buildings and central business districts, in effect creating alternative local telephone companies.

Firms also interlinked their computers, which became increasingly "distributed," via local area networks (LANs) which began as privately established high-volume links serving the data flows within an organization and among its equipment. In some organizations the internal flow

over LANs reaches 60 percent. Here, too, expansion was inevitable; some LANs grew geographically into WANs (wide area networks), even spanning several continents.

In time these elements came together and created intra-firm local networks, with multiple interconnections with the public networks.

The Service Economy

Although technology provided the impetus for private networks, it would be incorrect to view change only as technology-driven. At least as important, and a driving force for restructuring of networks has been the phenomenal growth of user demand for telecommunications, which in turn was based on the shift toward a *service-based* economy. The large users of telecommunications are corporate headquarters, banks, insurance firms, airlines, health delivery organizations, engineering and consulting firms, law offices, media organizations, and other providers of services. The shift toward such activity in highly developed countries was partly due to their loss of competitiveness in traditional mass-production *vis-à-vis* newly industrialized countries. It was also partly due to a large pool of educated people skilled in handling information. Information-based services, including headquarters activities, therefore emerge as a major comparative advantage of developed countries. These activities were reinforced by productivity increases in information transactions through computers and advanced office equipment.

In consequence, electronic information transmission (telecommunications) became of ever-increasing importance to the new services sector. It also became a major expense item. This made the purchase of communications capability at advantageous prices more important than in the past. Price, control, security, and reliability become variables requiring organized attention. This, in turn, led to the emergence of the new breed of private telecommunications managers whose function was to reduce costs for their firms and who, for the first time, established sophisticated telecommunications expertise outside the traditional telecommunications industry. These managers aggressively sought to establish low-cost transmission and customized equipment systems in the form of private networks of power and scope far beyond those of the past. In the spirit of Parkinson's law, they also created large departments. Some of these operations require hundreds of skilled technicians and managers. They began to carve out slices from the public network.

It does not take a large number of private networks to have an impact: In the United States, for example, the largest 3 percent of users typically account for 50 percent of all telephone revenues. These activities are spearheaded by private firms, but are not exclusive to them; non-profit institutions such as hospitals and universities, and public organizations such as state and local governments, are also actively pursuing similar cost-reduction strategies.

User Differentiation and Pluralism

By their very nature and tradition, the traditional monopoly carriers provided standardized and nationwide solutions, carefully planned and methodically executed. In the old days, sharing a standardized solution was more acceptable to users, because the consequential loss of choice was limited and was outweighed by the benefits of the economies of scale gained. As the significance of telecommunications grew, the costs of non-optimal standardized solutions began to outweigh the benefits of economies of scale, providing the incentive for non-public solutions. Furthermore, some users aggressively employed a differentiation of telecommunications services as a business strategy to provide an advantage in their customers' eyes, therefore seeking a customized rather than a general communications solution.

Another significant change occurred through the emergence of alternative transmission, starting with the Federal Communications Commission's (FCC) "Above 890" decision to permit intra-organizational microwave private lines.[4] Since then, numerous new facilities-based carriers offering transmission capacity have emerged, including international carriers such as Cable & Wireless, P-TAT, and PanAmSat; national carriers such as MCI and US Sprint; regional carriers such as RCI, Lexitel, and Allnet; specialized carriers offering microwave circuits (Eastern Microwave), satellite (Western Union), coaxial cable (Manhattan Cable), and fiber (Metro Fiber, FiberLAN, and Teleport); intra-building shared-tenant systems (STSs); and intra-organizational LANS. Thus, it has become increasingly possible and often desirable for users or systems packagers to put together segments of capacity and to fashion ad hoc private networks based on the most economical and effective capacity offers.

To add to the increasing differentiation, telephony has gone a long way beyond providing simple switched voice connections. A large

number of value-added services have been introduced, especially in data and text areas. Examples are voice mail, videotex and audiotex, and electronic message interchanges.

Conceptually, most advanced telecommunications services can be analyzed as four layers superimposed on each other: basic transmission, data packet transmission, generic services, and applications packages. Actual applications began with a mind-boggling complexity. Take for example a service we all use regularly, automated bank teller machines (ATMs). These services are often provided by a specialized private network operator serving a number of banks. This ATM network operates on private lines (basic transmission) leased from the basic network operator, typically the local exchange companies or long-distance carriers such as AT&T. These lines are used by data transmission companies such as Telenet, Tymnet, or the former AT&T Net 1000, which all add the packet switched capability used in interactive data transmission. Their services, in turn, are used by firms that enhance them further into generic value-added services such as on-line data access, electronic mail, voice mail, telemetry, and others. Such firms include MCI, GE, Tymnet, and AT&T Accunet. Different generic services are then bundled into application packages appropriate for various industries (finance, agriculture, hospitals) or functions (component part orders, international trade, credit card transactions, manufacturing designs).

While in many instances several of these layers can be integrated within the same company, they need not be. Thus, when a bank customer uses an ATM, the communications involved may involve five or even more functionally different service providers on the same physical segment, as well as several firms for the different geographical segments. The underlying banking transaction, in turn, may trigger interbank electronic transfer networks of similar complexity, using in turn special network arrangements.

Networks are not simply technical systems, they are reflections of interrelations among various groups, organizations, and individuals. The number of groups in society that interlink by telecommunications is large, and their communications needs as collectives became specialized. This led to the emergence of private user clusters. Early examples were travel agents and airlines, automobile parts suppliers, and financial institutions, which established group networks that combine some economies of scale with customization.

MODELING THE EVOLUTION OF NETWORKS

Foremost among the reasons for the emergence of private networks is cost, that is, their lower price to users. But why should it be cheaper to have specialized networks? To analyze this issue, the following section is a theoretical exposition of networks and why they tend to fragment with growth.

Networks are an important concept in society and the economy. They abound in various fields and in different forms. They include physical facilities for electric utilities, communications, and transportation, as well as relational systems such as networks of "old boys," political supporters, and intelligence agents.

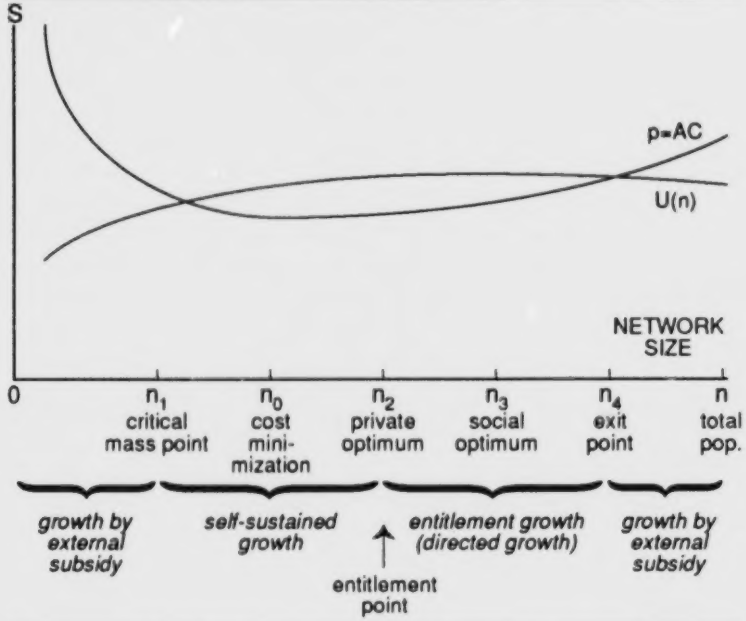
Telecommunications networks can be viewed as having qualities of both private goods and public goods. Pure private goods admit only one user while pure public goods admit everyone. What has been happening in recent years to telecommunications is largely a shift in the degree of its intermediate position in the direction of user associations.

A universal public network which connects everybody with anybody under a single organizational roof is technically and financially merely one arrangement out of many. One can view a network as a cost-sharing arrangement between several users. Figure 1 shows the size of a network on the horizontal axis. As the network grows in size, the average cost paid by each user first drops, then later rises as marginal locations are connected. The benefit of membership in the network, meanwhile, keeps growing, though at a declining rate. When first started, the network requires a certain number of subscribers to become self-sufficient—it must reach a size where benefits become greater than costs. Below that point, which may be called the "critical mass" point, the network needs some form of subsidy to cover its costs, from either government sources or its operator, as an investment in the future.

After this critical mass point, expansion of the network is self-sustaining, since newcomers add to the utility of the network without raising costs. However, at a certain "private optimum" point, newcomers are no longer welcomed, because costs begin to rise with each additional subscriber while incremental benefits stagnate. When this occurs, the network ceases to expand on its own.

For public networks, this private optimum point is not ideal; some potential users are bound to be left off the network. Therefore, univer-

Figure 1 Stages in Network Expansion



sal service policies in most industrialized nations help to open the network membership to further growth, and thereby to include as many users as possible.

However, these universal service policies may result in some users receiving less from the network than desired. Indeed, there may be an "exit" point where the network has expanded to the extent that, given its cost, a user is better off not participating; the user would rather drop off and be without service than participate in supporting the network.[5] More likely, however, is for some users to drop off and start their own new "network association" if they can do so legally and economically. This is particularly the case if they can interconnect with the remaining network. They can thus maintain the benefits of the network's large size without its cost-sharing burden.

These trends lead to what may be called "the tragedy of the common network," borrowing from Garrett Hardin's classic environmental "Tragedy of the Commons," because it is not the failing of the traditional

system, but rather its very success which undermines its continuity. As the above analysis outlines, the success of a communal network creates expansion, cost-shifting, and the forces for particularism. Because the combined volume of large users has risen so much, they can account for much of the cost savings of sharing just among themselves. They can form alternative network associations for large parts of their communications needs, first in-house, then with their closest suppliers, customers, or market partners.

These groupings of users need not be territorial. The tradition of interconnected national systems is likely to be transcended in many instances, and specialized transnational networks emerge. This becomes possible with the drop in cost of international circuits.

For satellite transmission, in particular, the marginal cost with respect to distance is close to zero. Communication flows can be routed in indirect ways in order to join new and more congenial network arrangements. Arbitrage becomes easily possible. This undermines attempts to administratively set rules for prices and service conditions.

In the future it is likely that specialized global networks will emerge for a variety of groups that communicate with each other intensely. Their relation to each other is functional rather than territorial, and they can create global clustering of economically interrelated activities much in the way that in the past related activities clustered physically near each other.

Examples for group networking are:

- advertising agencies, media firms, and printers;
- chemical manufacturers and environmental protection agencies; and
- insurance agencies, hospitals, record rooms, and police.

In some instances, these will have special performance features that distinguish them from the general "public" network. In the first example of the list, network bandwidth probably must be quite high to permit transfer of high-resolution graphics.

In other instances, additions of supporting software and data bases provide a more powerful communication, as in the second example. But in many instances, such as the third above, it is probably the price of inter-communications that drives the arrangement.

Many entities are likely to participate in several networks. Furthermore, the new and pluralist network system does not imply separate transmission links for each subnetwork at every point. It will often make sense to transport the traffic of several low-volume users part of the way on the general network until the point where there is enough aggregate traffic to branch off. The economics of sharing are not abolished. But they must prove to be superior as a matter of choice rather than being imposed by a legal requirement.

But why stop at networks for *groups?* If the trend is from national public networks covering the entire population to a pluralist system, why not expect still further disaggregation? This additional step means individualized networks, or *personal* networks, which may be called PNs, analogous to PCs. Before dismissing the notion of PNs as extravagant, let us remember that 20 years ago nobody expected personal computers, and nobody expected computers to end up on everybody's lap, either.

What does a personal network mean? It means an individually tailored network arrangement that fits an individual's communications needs. It does not necessarily mean a separate physical system, except for inside wiring and maybe the last mile of circuits, some radio-mobile links, and terminal equipment. The rest consists of what are called virtual networks, provided by a whole range of service providers and carriers, not just one, and packaged together to provide easy access to an individual's primary communications needs: friends and family; work colleagues; frequent business contacts, both domestic and foreign; data sources; transaction programs; video publishers; telemetry services such as alarm companies; bulletin boards scanned; etc. Contact to and from these destinations would move with the individuals, whether they are at home, at the office, or moving about.

The Second Electronic Coalition

For all of these reasons, public networks have been subjected to centrifugal forces. Like a Greek drama unfolding, the unified, centralized system unravels because it reflects the realities of a passing era. Technology and economics are tearing at the traditional unity. The centralized system frequently still has politics on its side. It still encompasses several of the main organized constituencies in industrialized countries. But the new interests create their political constella-

tions, too. Now, another grouping is emerging, the alliance of large users together with the most advanced part of the telecommunications equipment industry, which also includes the computer, components, and office equipment firms.

To conclude, the use-privatization of the public network is perhaps the major network development in recent years, yet it is little noticed in its cumulative implications since much of it takes place outside the traditional focal points of policy attention. Perhaps because of its technical complexity, this trend has not received the visibility and analysis it deserves and requires.

THE IMPACT OF THE NEW GROUP NETWORKS

The theoretical discussion in the previous section aimed at demonstrating the dynamic of disaggregation in networks. If one gives individuals the freedom of association, they will form new types of interlinkages which we call networks. What are some of the long-term implications?

Networks Will Become Transnational

As the cost of transmission continues to drop, the network associations will not be territorially organized. Territoriality was based on the need for a network architecture that primarily minimized cost by minimizing transmission distance. It led to the creation of the "German network," or the "French network." This technological and economic territoriality suited governments everywhere just fine, because they, too, were based on territoriality of jurisdiction, and could thus conveniently exercise control and even ownership over "their" networks. But things are changing. Now, networks are increasingly becoming pluralistic group affairs. Groups break off parts of their communications needs from the public network and aggregate them in their own associations. Banks, insurance agencies, airlines, automobile manufacturers, and many others communicate with each other on increasingly specialized networks. Advertising agencies, marketers, printers, and media do so similarly. Another group is automobile manufacturers and their suppliers, dealers, and financiers.

Territoriality becomes secondary. Many of these communities of interest transcend national frontiers. Their interests are continental and

global, and so are their networks. When the computers of brokers and investment banks in New York are interconnected by a continuous network and interact with those in Tokyo and London to trade and clear transactions, one cannot say anymore that there is a New York or Tokyo market. There is no physical locus for the market anymore. *The network becomes the market.* Transactions are not conducted at any particular physical point.

New Electronic Neighborhoods Will Emerge

A few years ago, it became fashionable to speak of communications creating the "global village." There was something inspiring in this image, communal and peaceful. But there is nothing village-like in the unfolding reality. Instead, groups with shared economic interests are extending national group pluralism through the opportunity to create global interconnection with each other into the international sphere. Indeed, communications make international pluralism easier because it is easier to reach critical mass for subnetworks if one aggregates across several countries.

The new group networks do not create a global village, they create instead the world as a series of electronic neighborhoods. In the past, neighborhoods had economic and social functions. In New York for example, there are Chinatown, the Garment District, Wall Street, Madison Avenue, and the Theater District. Elsewhere, there are regions with specialized production: Solingen and Sheffield for cutlery, Lyons for silk, Hollywood for films, Silicon Valley and Route 128 for microelectronics.[6] Production clusters create economies of aggregation that substitute for the economies of scale and scope of the giant multi-product firm. Physical proximity was a key. But now, group networks can serve many of the functions of physical proximity. They connect specialized producers, suppliers, buyers, experts, and markets. They create new ways of clustering, spread around the world.

Some of these electronic neighborhoods will be nicer than others. They will perform better, faster, and often even cheaper. In developing countries, the networks of those transacting with the world are already becoming better than those of local people. In places like China and Egypt, a two-tier communications system has emerged.

Networks might also be stratified along socio-demographic dimensions. Already, some long-distance resellers in the United States offer

bonuses to churches if they sign up their members. Such marketing efforts can lead over time to identification of some networks with particular ethnic, religious, or political groups. Similarly, some networks may be shunned by labor union members if they have a history of labor problems.

People or businesses could become identified with "their" network. A year ago, New York Telephone proposed splitting the 212 area code, with the Bronx and parts of Manhattan getting a new code. Many Manhattanites were upset to be lumped together with the Bronx and made themselves heard.[7] Governments might try to maintain systems of internal redistribution by resorting to taxation and allocation. A value-added tax on communications would be a sensible substitute for the present hidden system. But it will not be easy to define what will be taxed, or to measure it, or to prevent the taxed electronic flows simply to bypass the jurisdiction.

Networks Will Assume Political Power as Quasi-Jurisdictions

Historically, the nation-state was at tension with cross-border allegiances—whether proletarian international solidarity, rebellious youth culture, international financial capital, or ethnic minorities. The new network environment weakens national cohesion. It strengthens particularism and internationalizes it. It is difficult for a state to extend its powers beyond traditional frontiers, but it is easy for the new networks to do so.

Furthermore, these network associations possess and acquire powers of their own. They already may link powerful entities, and can bring their combined powers to bear. For example, the combined weight of the members of the SWIFT banking network got the powerful national Post Telegraph & Telephone monopolies to cave in on a number of crucial issues. And there is no reason to expect the power of network combinations to be directed only at communications issues. Once groups are in constant touch, they may as well get organized on other issues, too. *The communications network becomes the political network.*

They will coordinate in the economic sphere. When it comes to the role of information, the line between competition and cartel coordination has always been a fine one. In the 1920s, various American industries established so-called fair-price bureaus that gave each member of the industry a convenient look at what its competitors were

charging. This practice was outlawed in a series of anti-trust cases. Imagine if one leaves instead information exchange to a series of artificial intelligence programs communicating internationally. One has a real problem of conceptualizing, detecting, and preventing international cartels. One person's collusion is another person's programmed trading. *The network becomes the cartel.*

The network associations are also likely to become quasi-jurisdictions themselves. They have to mediate the conflicting interests of their members. They have to establish cost shares, sometimes creating their own de facto taxing mechanism as well as redistribution. They have to determine major investments, to set standards, to decide who to admit and who to expel. As a network becomes more important and complex, control over its management becomes fought over. Elections may take place. Constitutions, bylaws, and regulations are passed. Arbitration mechanisms are set up. Financial assessment of members takes place. *Networks become political entities.*

Thus, we may be witnessing the creation of new and often extraterritorial forms of new quasi-jurisdictions that are not clearly subordinated to others. In response, governments might create forms of domestic and international regulatory mechanisms for specified sets of problems, possibly based on global networks themselves that continuously collect and exchange information, track activities, and coordinate enforcement.[8]

Networks Will Exercise Power Toward Their Members and Restrict Free Speech

Perhaps the major long-term issue is whether a network group can dominate its own members, or be restrictive in its permission of others to join. The power of the network becomes most obvious when it is operated by a dominant entity. For example:

- As mentioned before, a network can be quite restrictive if its actual users are relatively captive, e.g., employees, students, patients, dependent suppliers. It can limit terminal equipment and options, charge monopolistic prices, and legally refuse to serve political activist groups.

- The major U.S. videotex service, Prodigy, prevents its user groups discussing politics on the system as well as the Prodigy system

itself. When Prodigy, which provides extensive messaging service, announced that it would raise the rates for such messages, a group of subscribers posted notices in a "public area" of the system encouraging other subscribers to protest. When Prodigy removed these messages, the protesters turned to the private message feature, and sought help from advertisers. Thereupon, Prodigy cancelled the subscriptions of the protesters.[9] The controversy over Prodigy suggests the increasing potential for blocking the right of free speech as technology allows new, private networks to develop.

- In 1987 a debate raged at Stanford University over a joke file on the University's computer system. Because it contained jokes offensive to some groups, the university was pressed to impose restrictions on content.

- Employers frequently block the ability of their employees to reach certain numbers. While this is based on protections against running up telephone bills generated by dial-it services, the principle could be extended to excluding messages of a type undesirable to employers, such as those of labor unions.

- In so-called intelligent buildings, landlords provide communications to occupants. These "shared-tenant services" are largely under the control of the building owners, whose interconnection decisions determine which networks tenants can reach.

- Electronic mail, which carries personal messages over computer networks linked by telephone lines, suggests a number of issues. For example: Do employers who own the electronic mail system have property rights to messages sent and received by their employees? Do employees have such rights to material sent on their employer's system? May employers read messages sent by their employees over systems owned by the employer? (In one instance, a mayor read the private electronic messages that city council members had sent to one another.) What rights of privacy extend to the information the system automatically generates about employees sending messages, e.g., records of who is communicating with whom, at what time, and for how long? Can the system owner exclude certain types of communication?

- Speech restrictions have already begun to appear on public networks as well: Telephone companies that have traditionally operated as common carriers, i.e., not discriminating among users based on the content of their messages, have recently sought to screen messages carried over their conduit based on maintaining their "business reputation."[10] Some telephone companies, both local and long distance, have chosen not to provide billing and collection services for certain "900" services, thereby raising the cost of doing business to providers that offer controversial speech. US Sprint has a staff of 22 enforcing its dozens of guidelines for "900" services. Sprint rejects 40 percent of all applications for this service based on its policies governing advertising, content, and other areas. (It does not permit calls to children under 13, services involving giveaways, or any service that the company, in its sole discretion, believes does not "provide value [in] proportion to its price.") AT&T previews the programs of service applicants, for example, of dial-a-joke programs. Ethnic or off-color jokes need not apply. Governments, in response to some abuse, have weighed in with a heavy hand, for example setting maximum prices that can be charged by such information providers and setting bars to lawful "adult" messages. With the similar logic of "business reputation," telephone companies could conceivably deny transmission service to private networks of controversial groups or any whose purpose they disapprove of.

Petty monopolies can thus emerge, largely unencumbered by the protections built into the public network, at least in the past, by law, custom, and regulation. The primary option is exit, which may mean giving up a job and departing to another institution organization with different policies.

Are there freedom of speech rights for users in group networks (in network terminology, "common carriage obligations")? The scope of these rights is undefined. Constitutional First Amendment rights do not appear to exist, given the absence of state action. Statutes apply only if there is evidence of discrimination. Regulatory impositions of such obligations are possible, but are limited by the rights of groups to substantially define their membership and the rules under which they operate, especially where a major purpose of the groups is commu-

nication, and thus the exercise of a fundamental right itself, i.e., of speech. In such circumstances group activities have protection from restrictive regulation. In other contexts, the exercise of speech rights is stymied by access problems, especially to the workplace or to the shopping malls that today take the role of public gathering spaces. By analogy, the access to networks might be foreclosed, and with it its free speech potential.

Many of these new communities of interest transcend national frontiers. Global, integrated private networks create their own First Amendment issues. In "cyberspace," where electronic interactions occur without physical location, how will nationality be determined? To what legal system or tradition will users be able to seek guidance or appeal? Under such conditions, the First Amendment may become little more than a "local ordinance," and in conflict with speech principles of other countries.

Even where network groups are organized democratically, they may well be restrictive. A major function of liberties, after all, is to protect minorities from unsympathetic majorities. In the public sphere, guarantees of free speech against governments are part of constitutions. In the network environment, the granting of access and non-discriminatory content-neutrality is required of the general "public" networks by law or common carriage regulation. But common carriage does not necessarily apply to group networks. Groups may institute restrictions on the exercise of speech over their network, and assert that their status is alike to publishers, with no rights of users. They can exclude certain subjects from being discussed, or certain speakers from having access to the network. This could become particularly an issue when telecommunications networks gain the ability to transmit video programs. It is true that individuals could form alternative networks if they are being restricted. Thus, market forces could help, but not if some of the networks control some segments of a chain of communications, or where the ability of any link in such a chain to institute content-based tests would impose transaction costs on the entire system. It is for similar reasons that society has adopted the use of legal tender and of commercial paper to permit low-cost transactions. Common carriage has a similar rationale.

One solution would be to impose common carriage on every network. But even if that were legally and constitutionally permissible,

it will not be desirable or possible to extend the common carriage model all the way into the last small group network or into a broadcast-like one-way network.

COMMON CARRIAGE RIGHTS-OF-WAY

One possible solution is the creation of bridge mechanisms. What is needed is to establish a set of principles to guide interconnection in a mixed private-public network system. Such principles would allow private network arrangements to connect to the public networks, as they do now, but would require a *reciprocal* arrangement: common carriage "rights-of-way." Such rights-of-way would function like public roads and highways that pass private property, or easements that allow public passage through private land. They would permit the unimpeded transmission of information across the network federation and enable end-to-end connectivity, although not necessarily on the entire bandwidth of a transmission, since this would be unfair to a network that started out with a different status. Some rights-of-way would be quite wide superhighways, while others could be narrow but otherwise unobstructed lanes. They would provide a portion of their capacity for common carriage use. Such a system would allow for many forms of private networks, which the owners control. But as such networks enjoy the benefits of interconnecting freely with the public networks, they need also offer some capacity for the reverse flows as a reciprocal right.

A model (albeit flawed) of how this might be constructed can be taken from leased access channels on cable systems. Cable systems are essentially private networks, and the network operator has almost total discretion in controlling access "downstream" to subscribers. However, since 1984, federal cable legislation has mandated that a portion of the channel capacity be made available to "persons unaffiliated with operator" in a manner that approximates common carriage (i.e., the cable operator establishes the rates and is for the most part barred from considering the content of the programming).[11] As such, a portion of the network capacity is set aside for "upstream" access for the use of program providers who are not otherwise "members" of the network or controlled by the network owners.

One drawback to the cable model has been that leased access channels are like islands—there is no easy connectivity among them or to providers of information. In the federated network of the future, rights-of-way could traverse the entire system, from carrier to carrier, allowing the public network to cross private networks in order to reach end-users efficiently as well as allowing private networks to use the public network. Such an arrangement would strike a balance between the conflicting legal status of the public and private networks, and between traditional telecommunications and mass media.

We have all heard about the merging of electronic communications. But this has been essentially a technologist's vision, with policy trailing far behind. Common carriage rights-of-way provide a tool of integration for the increasingly centrifugal network environment.

CONCLUSION

Group formation always had a double-edged aspect. On the one hand, it was an extension of individual rights. De Tocqueville noted that the "right of association . . . almost is unalienable in its nature as the rights of personal liberty." On the other hand, freedom of association led to situations inimical to individual as well as to a more general public interest. While many are agreed with the significance of pluralism,[12] others note the negatives.[13]

The exercise of freedom of association may lead to group formations that are restrictive of speech. Hence, the evolving pluralistic structure of telecommunications may bear the seeds for a new type of bottleneck to the free flow of information that did not exist on the traditional public network and its common carriage. It is a challenge to communications policy to keep the network system open from end to end, and to provide integrative tools for its diversity which do not result in fragmentation.

APPENDIX
POLICY CHALLENGES POSED BY THE GROWTH OF PRIVATE NETWORKS

The growth of private networks raises a host of policy issues that require further analysis in light of the emerging network environment.

Consumer Protection

User Sovereignty. A major question is whether a network group can dominate its own members or be restrictive in its permission of others to join. As more consumers are connected to private networks, their access to the benefits of service and equipment competition can be thwarted. How can consumers ensure that they will be able to use their choice of equipment over networks outfitted only for proprietary devices? If their local networks do not permit them to receive the desired service or functionality, what rights do they have to obtain access to a rival system, or simply to the public network?

Privacy. As private networks evolve, they incorporate many advanced features, which will contribute to and draw from personal data bases. As a result, a new generation of privacy issues is arising, which present laws and regulations do not appear to cover adequately and competitive forces may not help to solve.

Impact on Public Network Providers

Cost and Upgrade Impacts to Public Networks. The public network provides value to users of alternative networks in ways that are not obvious. For example, it is available as a backup if faults develop in a private network or if capacity is reached; hence private networks can adopt a less costly standard for reliability. It also provides standardized protocols and so forth. Clearly, the development of private networks will have an impact on public network costs (as distinguished from revenues). Is it possible that there could be a subsidy from the public network to private ones (i.e., from residential or other small users to large business users), reversing the historical flow?

Revenue Impacts on Public Networks. As users leave the public network, traffic is negatively affected. Price competition among networks may result in still lower revenues. It may require new internal

pricing rules for services. As a result, investments and upgrades to the public network may suffer. This may serve to diminish service quality on the network and affect the competitiveness of the network.

Financial Interconnection. The major issues are (a) the optimal extent of unbundling, and (b) access pricing from one module to another. A related issue is the ability of other networks to interconnect physically on the premises of the public network. This is the highly controversial issue of collocation.

The Stability of the New System: Is a Network of Networks Sustainable? Public (open access) and private (closed access) networks co-exist and create an interdependence of users and networks. The stability and sustainability of this co-existence and the potential dominance of centralism, co-existence, or fragmentation needs further analysis.

Technical Issues

Standards and Technical Fragmentation. As the number of nonpublic networks increases, so does the technical complexity and diversity of networks, as users supplement or replace public transmission and software-defined offerings with customized additions. Given the technical nature of private networks, how will multiple standards be most effectively interconnected? What impact will this fragmentation have on innovation in the equipment industries of the United States and abroad? How will technical standards affect network performance and cost for users and suppliers? Under what conditions will technology and services emerge which are superior to those of a centralized system? When will they be inferior?

Standards are often used as tools of competitive strategy. What should be the role of government and of regulatory bodies—national and international—in the standardization process? Will a decentralized network system converge toward standards through market forces? What will be the role of private systems integrators in this process?

Interfaces and Principles for Modularizing the Network. In an interconnected network system based on hardware and software interfaces, it is critical to develop network concepts and principles organizing hardware and software functions in a way that makes interconnec-

tion feasible. This requires conceptualizing a network system based on unbundling and modularity. How is this related to ONA and ONP constructs? What is the optimal content of network unbundling?

Models of Interconnection. Mechanisms by which networks interconnect physically, virtually, and electronically, and evolving access arrangements, must be examined.

The Interconnectivity of Software (including software collocation) and Network Management Functions. The key to constructing hybrid networks—part private leased lines, part virtual private network (VPN), part public carrier—lies in software compatibility and interactive network management functions. These issues and their impact upon the open systems movement, both theoretically and practically, must be studied.

Service Quality in the Network of Networks. With the shift toward incentive forms of regulation, the importance of analyzing service quality in telecommunications has grown. In a network of networks, degrees of quality offered by various components become interdependent.

Capacity Planning in a Decentralized Environment. With the decentralization of networks and their interconnection, independent suboptimizing decisions on investment and capacity might not result in overall efficiency. What "invisible hand" mechanisms may exist in a federated network environment, and what are the possible remedies if they do not?

Emergency Planning. Because of changes in competitive market forces, network providers are not likely to build as much redundancy into their networks as in the past. As a result, emergency preparedness may suffer. Similarly, in the case of service breakdown in a private network, excess demand may be put on a public network. One solution may be to grant mutual access between all or a majority of networks in times of emergency, similar to the Emergency Broadcasting System for broadcasters. Which access priorities should underpin such a system? How should networks vital to national and international emergency preparedness be hierarchically structured?

Common Carriage and Access

Mixed Public-Private Systems. The status of common carriage will need to be analyzed for its applicability to the changing nature of networks. We are experiencing head-on collisions between the separate principles which have dominated the telephone, cable television, and broadcast industries. Additionally, many networks are now offering both private and common carrier-type services. The developments require the coordination of a mixed private-public network system. Such a system would permit private network arrangements but would also protect, or create, common carriage "rights-of-way." This issue is of immense importance to the future status of network operations.

Access to Private Networks, Closed User Groups, and Public Networks. How to provide access among networks, such as from a shared tenant services telecommunications network to the public network, is far from established. Closed user groups will vary in size and sophistication, yet will need access to larger networks and the public network on equitable terms. On the other hand, they will not grant access to all who wish to use them. The altered network environment creates a new generation of access issues. What are the possible conditions and terms for access to the wide range of users? What are the important policy and legal issues pertaining to rights of access? Can a network group dominate its own members, or be restrictive in granting permission to others to join? What are the long-term implications of user and network control over access? Similarly, according to which criteria should closed user groups be allowed access to larger and/or public systems? Perhaps the major question is whether a network group can dominate its own members or be restrictive in permitting others to join.

Often, conflicts arise among users of private networks. Although initially users of an alternative network will share some commonality of interest, this may change over time and conflicting interests may come to dominate. This could occur as a result of such causes as, for example, a change in the ownership of one of the users, the eventual arrival of diseconomies of scale, or divergence in needs and corporate strategies. The stability of the new coalitions needs to be studied, and constitutional and anti-trust aspects of new network associations thought through.

Pricing and Tariff Policies

Access Charges for Private Network Users Interconnecting with Public Systems. How should access charges regarding the use of one network (or elements thereof) by another network be set for optimal results?

Alternative Mechanisms to Subsidize Universal Service Provisions. Private networks spur the migration from public networks, which destabilizes the funding for traditional mechanisms designed to encourage universal service. Policy makers must examine options for alternative subsidy funding and assess the feasibility of various tax mechanisms, how they might be levied in practice, their likely incidence, and how they would best be allocated.

Technology Policy

The Impact of Private Network Developments on National Competitiveness. How will innovation in equipment, service provision, and user applications affect the international competitiveness of the United States, as well as the performance of other countries? How significant is telecommunications network usage as a source of general revenues?

The Feasibility of Partial Regulation of Network Building Blocks. Different providers and users will own or control certain network components, both hardware and software. With connection among the various public and private networks, the facilities of numerous providers will be used. Some portions of such systems are today (and probably will remain) subject to regulatory oversight, while others will not.

Government Support for Private Networks. The importance of certain types of networks to national social and economic goals is likely to grow. Governments may therefore provide incentives and financing to encourage their development. What are the theoretical, policy, and practical issues associated with government support for creating specialized private networks?

Global Private Networking and the Ability to Fashion National and International Policy. Decentralization of networks and their transnational aspects challenge government and regulatory control and the coordinating and market-allocating role of international telecommunications organizations. How might domestic regulation and international ar-

rangements be affected? How might they evolve? Is a globally decentralized system viable?

Redefining the Concept of Infrastructure. Because of the centrality of information and its transport to the economy, the emergence of the network system—shaped by business demand, carrier strategy, public policy concerns, and international forces—has important consequences. What constitutes infrastructure in such an environment, and the extent to which the government will or can extend its authority over that infrastructure, will be crucial policy issues in such a network environment.

ENDNOTES

1. Crandall, Robert W., *Fragmentation of the Telephone Network: Implications for the Policymaker*. Washington, DC: Brookings Institution, 1988.
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3. The author served on the Selection Advisory Committee for the FTS-2000 procurement.
4. *Allocation of Frequencies in the Bands above 890 Megacycles*, 27 FCC 359 (1959).
5. See, for example, E. Noam, "A Theory for the Instability of Public Telecommunications Systems," in Cristiano Antonelli, ed., *The Economics of Information Networks*. Elsevier, forthcoming; G. Heal, "The Economics of Networks," unpublished paper, Columbia Business School, October, 1990; G. Chichilnisky, "Networks and Coalition Formation: Externalities and Increasing Returns," unpublished paper, Columbia University, Department of Economics, July 1990; and K. Hayashi, "The Economies of Networking: Implications for Telecommunications Liberalization," unpublished paper, IIC Conference proceedings, Washington, DC, September 1988.
6. Piore, Michael, and Charles Sabel, *The Second Industrial Divide: Possibilities for Prosperity*. New York: Basic Books, 1984.
7. The alternative proposal was to assign all *new* lines to the new code, which would have created the possibility, for the first time anywhere, for "his-and-her" area codes in the same residence.
8. The optimal size of jurisdictions was always dependent on communications. French departments were based on the distance that a horseback rider could cover in a day. Transportation and communications technology changes the optimal size. It's hard to imagine a voluntary European integration without telecommunications.
9. Professor Henry Niman, per Marc Rotenberg, communication.
10. Some regulatory commissions, most notably New York's (but not the FCC) resisted; but at least one major court decision, in a muddled opinion (*Carlin Communications Corp. v. Mountain States Tel. & Telegraph*, 827 F.2d 1291 [9th Cir. 1987]), seemed to permit restriction.

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What About Privacy in Universal Telephone Service?

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INTRODUCTION

When we think abstractly about privacy, we tend to order it among the most cherished values of liberty in an ordered society, alongside freedom of speech and religion. But our sensitivity to privacy interests varies with circumstances.

When we decide to board an airplane, we virtually line up for privacy invasions. When we use our credit card, we give out information—from our home phone number to what kind of tipper we are—to a host of people who we never meet face to face. Shop for batteries at Radio Shack or a toaster at Circuit City, and you'll be asked politely, but firmly, for your home address by someone you don't know wearing an orange vest.

Privacy is situational. Some invasions are serious, if not revolting. Others are irritating but not serious. And others we willingly endure in order to get something in return.

In the scheme of things, telephone privacy is not necessarily the most profound concern. In the age of AIDS, divulging a person's HIV antibody status is a privacy matter of great significance in terms of employment opportunity and social stigma. In the age of electronic banking, divulging a person's credit rating can restrict social and economic mobility.

Even in the specific area of social issues arising from telephone use, privacy issues do not dominate the agenda. The risk of information

overkill from political telemarketers poses a great harm if low voter registration levels are any indication. For all of its benefits, telecommuting carries the spectre of electronic sweatshops; if a person's home is the castle, the home office can become the dungeon.

Still, even if telephone privacy is not the dominant social issue of our times, it looms large in the privacy debate. For one thing, telephone privacy directly relates to other privacy problems in society. Unlawful government and private wiretaps and credit reporting abuses would be impossible without extensive use of the telephone, and these certainly top the list of privacy matters in society. Modems make the telephone a central player in any information storage system and in what is collected about a person.

To telephone executives contemplating a new service, privacy may be among the last elements to be considered in product development. Not that privacy is unimportant, at least publicly. Rather, it is seen as an issue that can be influenced, and managed, by public relations. To ignore the privacy element in emerging telephone services, or to relegate it to an afterthought of marketing and public relations, is a mistake. But the mistake is foreseeable. Unlike manufacturing cost-outs or marketing strategies, telephone companies possess no process for factoring in the privacy aspects of new services. A few sociologists have examined these questions for the telephone companies,[1] but the discussion about privacy in new services almost appears after the fact, as opposed to being part of a product's design and development.

But privacy is important. There are some privacy interests for some subscribers that cannot be bought or coaxed away. It is at these non-negotiable points that privacy becomes part of the task of defining universal telephone service. Like universal service, privacy is imbued with an expectation that minimum standards will be met.

Drawing the limits of privacy in a universal service definition is difficult, growing more complicated as the communications infrastructure expands. The continuing deployment of fiber optic cable will extend the speed and quantity of communications. The exploitation of Signalling System 7 services will uncover new ways to process information about the calls we make. Increasing reliance on communications technology will replace many face-to-face transactions. These changes in our phone system carry with them significant opportunities for self-realization and threats to human privacy.

How should universal service account for its privacy complement? This article will examine the personal stakes, in particular privacy, implicated by the expanding telecommunications environment and by our increasing understanding of the significance of that environment on the individual. First, it will examine what universal service means today in terms of individual rights. Second, it will examine the privacy stakes implicated in telephone service. Third, it will look at legislative and judicial efforts to delineate privacy rights in the telephone context. Finally, it will suggest what universal service ought to include, from a privacy point of view, in a post-universal-service world.

UNIVERSAL SERVICE: PAST AND PRESENT

The concept of universal service has been the lode star for telecommunications policy developed over nearly a century. Its author was Theodore Vail, who became manager of the Bell system in 1907 and established policies that were to dominate the company and national telecommunications policy until the 1970s.[2]

Vail faced a turnaround situation at a somewhat moribund Bell system. His strategy was to use Bell's emerging long distance network as a competitive weapon against independent telephone companies by refusing interconnection to that network. This led to Bell's purchase on favorable terms of many of the most profitable independent systems and to a monopoly position for the Bell system.

Faced with the threat of anti-trust action by the Justice Department and the rise of nascent state regulatory public utility commissions to supervise the industry, Vail decided to forge a partnership with the public sector. The Bell system would submit to regulation regarding the price and quality of service by means of rate-of-return regulation. In exchange, regulators would prohibit entry of others to compete against Bell and let the company operate as a regulated monopoly.

Vail made one promise more: There would be interconnection with the telephone system within the reach of all.[3] This availability of reliable and affordable telephone service constituted the core concept of universal service or, as Vail announced it 1908, "One policy, one system, universal service."[4]

As far as providing dial tone service and access to long distance, Vail's promise has been kept. Even after the introduction of competition

at various levels of the phone system—beginning with customer equipment, then interexchange transport, and, increasingly, access to interexchange transport—and the breakup of AT&T in 1984, subscription levels remain high. By the end of 1990, the U.S. telephone penetration rate (that is, households with a telephone) stood at 93 percent, and household access to a telephone (via a neighbor's telephone, a public telephone, and the like) reached 95 percent.[5] Basic telephone rates have increased by just over 10 percent since 1986, representing a real-term decline in prices, taking account of inflation as measured by the consumer price index.

With the ubiquity of phone service today, some conclude that universal service is no longer a relevant concept. For one thing, there seems little modern evidence, even during periods of regulatory instability and economic downturns, of large numbers of persons losing access to telephone service. More importantly, the concept sets up the wrong question. By focusing narrowly on Vail's credo—the right to make and receive telephone calls—without considering many other rights, benefits, and interests implicated by telephone service, the universal service concept runs the risk of tunneling our vision about what phone service is, or could be.

Our idea of connection to the public network is changing. "Smart cards" (akin to today's telephone credit cards), already deployed experimentally, permit their owners to make a telephone call from any instrument. The card, rather than the telephone instrument, becomes the key to accessing the phone system. Technologies like personal communications services (PCS), under consideration by the Federal Communications Commission (FCC)[6] could amount to a poor man's cellular telephone—a wristwatch-sized device that would travel everywhere with the individual. These changes suggest that dial tone service is only a part of the universal service story.

THE PRIVACY STAKES IN TELECOMMUNICATIONS

While the scope of universal service is changing, the bedrock desirability of affordable phone service widely available to all of us is not. And increasingly, privacy is mentioned as a part of the bundle of rights that universal service ought to comprise.

Efforts to invade telephone conversations, and to protect against such invasions, are as old as the telephone itself. The first patent for a telephone scrambler was issued in 1881, five years after the phone itself received a patent.[7] Telephone wiretapping was widespread in the years before World War I. Given the opportunity in 1928 to declare taps a violation of the Constitution's Fourth Amendment guarantee against unlawful search and seizure, the U.S. Supreme Court declined to do so.[8]

In telecommunications, the right to privacy generally comprises two values: "the right to be let alone"[9] and the right to control dissemination of personal information, i.e., how information about the self is communicated to others.[10] As the distinguished writer on privacy, Alan Westin, formulated it more generally in *Privacy and Freedom:* "Privacy is the claim of individuals, groups or institutions to determine for themselves when, how, and to what extent information about them is communicated to others."[11]

There are myriad privacy issues raised by provision of simple telephone service. These concerns join the historical problem of police wiretapping of phone lines.

The right to own a telephone number: In business and personal life, a phone number is part of an individual's identity. Who has the right to a telephone number, the phone company or the subscriber? What policies should determine transportability of a phone number? To what extent are those policies artificially influenced by the North American Numbering Plan?

The right to keep a phone number from being disclosed: Telephone companies typically charge subscribers an added monthly charge for the right *not* to be listed in the phone book. Rather than being a privilege usually obtained by the rich, surveys show that lower-income people are readier than those with higher incomes to spend money to remain unlisted.

The Los Angeles–Long Beach metropolitan area, at 60 percent, maintains the highest proportion of unlisted residences in the United States. Curiously, of the 12 U.S. cities with the most unlisted numbers, 11 are in California, the exception being Las Vegas. More than 28 percent of the nation's phone numbers are unlisted, up from about 22 percent in 1984. Californians pay 30 cents per month to be unlisted. In New York the fee is $1.88, and in Idaho, $4.00.[12]

The right to control customer proprietary network information: To conduct its business, telephone companies collect data on a person's calling behavior. For example, the company could know a person's busiest hours of phone use, the average length of a call, or the most frequently called geographic areas. This information, known as customer proprietary network information (CPNI), could be helpful to the subscriber in the way that any neutral data collection about personal behavior would be.

It could also be useful to others who wish to gain a profile on the individual. Does the individual have the right to know which non-toll calls are made from her phone? Under what circumstances can the phone company release that information to marketers who might wish to use calling patterns to determine a consumer profile of the subscriber?

The expectation that calls between consenting parties will be kept secret: The law generally requires that law enforcement officials obtain a court order before a telephone may be tapped. Private tapping is forbidden. But we all know non-police interception occurs, by accident or design. What protection should individuals have to be sure that an extension line is not picked up during a phone call? Can the phone company guarantee better security against "lines being crossed" and conversations being heard by unintended parties?

The right to operate cordless telephones: Cordless telephones operate on radio frequencies that are not secured for each caller, increasing the likelihood of conversations being overheard by other neighboring cordless phone users or intentional eavesdroppers. Will such problems increase with the advent of PCSs, which also employ a base unit and headset equipment?

Caller identification: Caller-ID, a form of the more generic caller number identification or automatic number identification (ANI), reveals to telephone call receiving parties the number from which the call originates. The advantage of the service is that is permits a recipient to screen calls based on the displayed number and to track the source of unwanted or obscene calls.

But does caller-ID violate the privacy interests of the calling party, as one Pennsylvania court has determined, because it discloses the

number a call comes from?[13] Or does the caller give up the right to control this information by deciding to use a phone?[14]

The caller-ID debate has been complicated by the different ways in which it can be offered—per-line or per-call block.[15] Congress has recently considered regulating caller-ID to mandate per-call blocking.[16]

Right to avoid unwanted communications: Avoiding calls is the other side of the caller-ID debate. Allowing an ordinary ringing telephone into the home means that a subscriber's solitude will be interrupted to some degree. By custom, not every call will be anticipated. But unwanted telemarketers, obscene phone callers, or others known to be undesirable violate a subscriber's solitude.

Caller ID may violate the privacy of the calling party. But what of the privacy interests of the recipient of calls? Caller-ID is one technology-driven means to address this problem. To what extent should a telephone company protect against unwanted calls beyond caller-ID?

JUDICIAL AND LEGISLATIVE APPROACHES TO PRIVACY INTERESTS IN COMMUNICATIONS

Development of the Law of Privacy

For a nation that prizes privacy, it is notable that the U.S. Constitution does not mention it as a specific right. Instead, the Constitution's Ninth Amendment,[17] among others, provides support for the long debated "right of privacy" that the U.S. Supreme Court recognized first in the birth control case, *Griswold v. Connecticut*, which gave individuals a privacy right to use contraceptives.[18]

Telephone privacy ranks as an important privacy concern of the public. A Harris survey asking about the dangers of collecting personal information on computers found that, of the 13 items read to the respondents, the one consistently most disapproved of was "keeping computerized records of all telephone calls made from a number." Indeed, keeping records of telephone calls was considered *more* dangerous than maintaining records of political affiliations and associations, results of psychological tests, and results of intelligence tests.[19]

The literature of privacy is as extensive as the circumstances from which privacy concerns are thought to arise. Its most familiar

formulation is the "right to be let alone," words used by Louis Brandeis and Samuel Warren in their seminal article on privacy more than 100 years ago.[20]

Over the course of history, privacy has been a function of wealth. The power to exclude others from what we say, do, or think, or, conversely, to exclude ourselves from the bruit of others, often correlates to wealth and power in society. Generally speaking, those with the most to protect and the means to do so have been the ones who have enjoyed privacy. The extent to which this power becomes a guaranteed right under law is the difference between a mere expectation of privacy and what law ensures.

Privacy notions are also influenced by social and cultural factors. What for some is a matter of the most intense privacy is for others an event to be more widely shared. For instance, the confession of a member of Alcoholics Anonymous is done publicly within the group. The same confession of the Catholic penitent before a priest is performed in privacy and is protected from being divulged under the common law rules of evidence. As James Katz points out, privacy has grown as a function of technology. Changes in housing 250 years ago, such as internal doors, hallways, and stoves, permitted people to distribute into separate living quarters. Privacy became less the preserve of the rich and something shared by members of society generally.[21]

Privacy, at least as it concerns the telephone, is cultural as well. Three decades ago, telephone booths *were* booths; today many pay phone stations offer no privacy to the caller.

In Japan, it is common to have the telephone located in the middle of a room, as opposed to a corner. There is less expectation that the call will be private. In Germany, telephone bills are not itemized. This non-itemization is justified as a matter of privacy. It prevents readers of a person's bill from knowing which numbers were called. On the other hand, in France, until quite recently, public figures routinely listed themselves in the French telephone directory. Imagine finding Sartre or Malraux's home number listed in a public directory in today's celebrity-mad culture!

In the United States, some sex chat 900 dial-it services advertise that the charge for connection "will appear discreetly" on their phone bill as a fee paid some nonsexual-sounding communications company. And the speaker phone, once designed for group meetings and hands-free

calling by business, has become ubiquitous, with a greater likelihood that parties other than those speaking may be listening.

Judicial attempts to describe privacy rights have evolved in a variety of contexts, depending on what kind of privacy right was implicated. Wiretapping and other forms of electronic eavesdropping constitute the traditional category of privacy problems. But as Prosser pointed out in his classic formulation of the definition of privacy,[22] there are significant privacy concerns that go beyond the government's use of electronic surveillance.

Prosser's four categories are:

- *Disclosure of private facts:* This tort involves publishing true but intimate or private facts about a plaintiff such as details concerning sex life or health. The facts are true, but divulging them is deemed to constitute legal injury.

- *Intrusion:* This tort, related to trespass, involves invading the plaintiff's "private" space or solitude. It is here that wiretaps and other eavesdroppings are categorized. But peeping through the bedroom window or bringing a secret camera into a person's home would also constitute a form of intrusion.

- *"False light" invasion of privacy:* This tort, reminiscent of defamation, arises when a party has placed another in a false light in the public eye by disclosing a personal detail that is false. For instance, disclosing an auto accident victim's name may not be an invasion of privacy. Reporting incorrectly that the victim suffered brain damage might constitute a false light invasion.

- *The right of publicity or appropriation*[23]: This right is really not a matter of privacy so much as it is the commercial exploitation of a person's name or likeness, such as the unauthorized use of one's name or picture in advertising endorsing a product.

The right of privacy has developed as a common law principle in most states, although some, such as New York, have codified the right of privacy and may not even recognize common law privacy rights.[24]

Now, Prosser's definition was not meant to apply directly to telephone privacy. But the categories fit somewhat. Disclosure of a

person's phone number, for example, can possibly lead to legal injury—the outlawing of caller-ID in Pennsylvania suggests this. Unwanted telephone calls resemble the intrusion tort. Mispublishing a company's phone number to suggest that they do not exist where they say they do—a Beverly Hills company listed with a non-Beverly Hills number—resembles the false light tort. And selling details about a person's calling pattern (CPNI, discussed earlier) for commercial gain could come under the right of appropriation.

Legal development of the right to privacy with respect to telephone subscribers has centered around the wiretapping issue. Many privacy questions raised by telephone use—such as whether the unlisting of a number is a right or a privilege, or whether a cordless telephone must provide secure communications—have not been treated as privacy issues. Instead, their treatment has often been muddled in the law, developing as part of broader regulatory policies imposed on phone companies by state utility regulators or the FCC. For instance, phone company rates for unlisting a person's phone number would arise in the context of a tariff filing submitted for approval to a state public utility commission. Similarly, the privacy aspects of a cordless phone would be considered, if at all, by the FCC's Office of Engineering and Technology under its type acceptance program.[25]

Judicial and Statutory Treatment

The law of telephone privacy can be characterized by intermittent bouts of thrust and parry between the courts and Congress. In at least two instances in this century, the Supreme Court declined to find that an individual had an expectation to a right of privacy only to have its determination undone by Congress.

In 1928, the Supreme Court confronted wiretapping and privacy. In *Olmstead v. United States* it held that wiretapping involved no "search" or "seizure" within the meaning of the Constitution's Fourth Amendment, which prohibits "unreasonable searches and seizures." The majority judged that the Fourth Amendment "itself shows that the search is to be of material things—the person, the house, his papers or his effects." It concluded that there was no "searching" when a suspect's phone was tapped because the Constitution's language "cannot be extended and expanded to include telephone wires reaching to the whole world from the defendant's house or office."

Six years later, with the passage of the Communications Act of 1934, Congress forbade any wiretapping without consent under any circumstances by anyone.[26] The Communications Act did not contain an exclusionary rule. But relying on the act, federal courts could hold inadmissible wiretap evidence obtained in violation of the section.

Later, in a pair of decisions in 1967, the Supreme Court placed the prohibition against the use of warrantless eavesdrop evidence in both federal and state courts solidly on a Fourth Amendment basis, in *Burger v. New York*[27] and *Katz v. United States*.[28] In *Katz*, the Supreme Court reversed *Olmstead*, holding that the Fourth Amendment protects people, not places. The *Katz* case directed the Fourth Amendment privacy inquiry to whether the *individual* had an expectation of privacy in a particular conversation. If so, the products of a tap of that conversation without a judicial warrant would be excludable in a criminal proceeding against the target of the tap.

Congress shortly thereafter expanded the rules regarding the admissibility of eavesdrop evidence gathered without court order or consent. In Title III of the 1968 Omnibus Crime Control and Safe Streets Act,[29] Congress provided a comprehensive scheme for regulating interception of wire or oral communications. This act covers ground largely untouched by statutes or judicial opinions.[30] It prohibits all private eavesdropping and government eavesdropping without a court order, provides a procedure for obtaining such an order, and gives a private right of action to those whose communications are wrongfully intercepted.

In addition, it restricts access to intercepting devices and imposes an exclusionary rule on all eavesdrop evidence seized without a court order. The act was adopted in light of the widespread disregard of the Communications Act's prohibition on warrantless taping by public officials and private individuals as well as the growing concern with organized crime in America.[31]

In 1966, the Supreme Court retreated some from the *Katz* case in *Smith v. Maryland*.[32] That case held that no search occurred and no warrant was needed when police used a telephone company's pen register, a mechanical device placed on a telephone line to record all numbers dialed from the telephone as well as the time of dialing. A majority of the Court believed that there was no legitimate expectation of privacy in the numbers dialed.

Congress again expanded privacy rights by reversing the Court's direction. It overruled *Smith* in the Electronic Communications Privacy Act (ECPA)[33] in 1986, supported by a coalition that included the telephone companies, law enforcement agencies, and the American Civil Liberties Union. The act was aimed at addressing the inadequacies of the 1968 Omnibus Act. Rather than protecting only aural communications on telephones, as Title III of the 1968 act had done, ECPA protects nearly all forms of electronic communications as well as the computer facilities involved in such communications, such as networks and electronic mail, or E-mail.

The extension of privacy protection to the growing E-mail community also alleviated the concerns of foreign government agencies operating or receiving data service from the United States. ECPA also specifically rejected the Supreme Court's conclusion regarding toll records in *Smith v. Maryland*, providing that "no person may install or use a pen register or trap and trace device without first obtaining a court order."[34]

On the other hand, ECPA loosens privacy protections in terms of governmental access, particularly in allowing the government to more freely monitor communications usage, if not the communications themselves, without court approval. For instance, the government is now freer to count how many calls are coming from which phones or the destination of calls made from a particular phone. While helpful in enforcement efforts against drug dealers, this power also permits the government to know the calling patterns of citizens or monitor phones of bureaucrats for leaks to the press.

In addition to Title III and ECPA, Congress has enacted legislation that gives people expectations of privacy and certain information held by others, including credit status,[35] education records,[36] financial records,[37] cable subscriber records,[38] and video rentals and purchases.[39]

RECONCILING PRIVACY RIGHTS IN A WORLD OF INFORMATION FLOW

Universal Service and Privacy Compared

At a basic level, universal service and privacy are at odds. Vail offered the notion of a ubiquitous telephone network in which all could have access to all others on the network. It emphasized a system of access to

reach others, not a regime of privacy so the individual could be let alone. Universal service is premised on the expectation that people want to receive calls, not the opposite. Privacy in telephone service, as in society generally, stems from the historic right to remain inaccessible. This includes not merely physical inaccessibility but also the right not to receive communications despite the motivation or desire of the sending party.

The apparent conflict between universal service and privacy can be theoretically resolved by recognizing that universal service does not guarantee that a communication will proceed. Vail only intended that everyone could have access to send and receive telephone messages, not that they would always elect to exercise it.

But there is a potentially more divisive way that universal service and privacy intersect and work against each other. Universal service is premised on the affordability of basic telephone service for all. As cost-based pricing has challenged that premise, federal and state regulation has tweaked the system to ensure that lower income Americans stay on the network. Targeted federal/state subsidy programs encourage low-income households to subscribe initially and to be excused from paying full subscriber line access charges[40] (through "Link Up America") and to remain on the network (through "Lifeline" phone rates).

As noted, privacy more often than not is a question of money. More privacy involves greater cost. Hospitals provide an analogy. A semi-private room in a hospital is less costly than a private room. Some hospitals provide only private rooms based on the view that anything less private would be unacceptable from the patient's viewpoint. Others, such as military facilities, assume that private rooms are a frill to be dispensed with in all but the most severe cases. And hospital reimbursement policies, whether by government or private insurers, are another form of informal "privacy policy," akin to the rate structure for unlisted phone numbers mentioned earlier. For instance, if a hospitalization reimbursement policy provides for payment for only the least expensive type of hospital room and a hospital only provides private rooms, a level of privacy will be guaranteed unintentionally.

Some persons go to great lengths to ensure privacy; for others, the curtains to their lives are seldom closed. Given the relative importance of privacy as a value, it's fair to say that most people would like to have the question of privacy presented to them rather than letting business or government regulators make the decision for them.

Here is where privacy and universal service conflict. Were a revised definition of universal service to include an expansive definition of privacy, it might make telephone service unaffordable for some. For others, for whom privacy is less significant in the telephone context, a strong privacy requirement imposes an otherwise avoidable cost.

To illustrate, consider caller-ID. Instead of being offered as a supplementary service as it is in some states today, suppose state regulators concluded that the right to know an incoming caller's telephone number is an essential privacy right that must be part of the universal service definition. Accordingly, the basic monthly rate for residential service would include caller-ID. Deployment across the whole network would reduce the per-month cost of the service below current pricing levels. But cost of installation, equipment, and maintenance would be unavoidable. These costs would be passed along to all subscribers, consistent with the regulators' new definition of privacy. Privacy and cost of service become linked. More privacy might cause the price of service to go too high.

A more immediate example underscores the point. As noted, declining to list one's telephone number in the phone directory incurs an additional charge. What if the presumption ran the other way, i.e., for reasons of privacy, the right to be listed in a telephone directory's white pages would be an option available, at additional cost, to the subscriber? Privacy would then cost less than it does today.

A similar issue was avoided in 1991 when Pacific Bell switched all residential phone service in California to touchtone dialing, without increasing rates for those with rotary service. The move was part of an agreement with the state public utilities commission. One of the goals of the switchover was to allow all consumers, including rotary phone users, to access the growing array of information services requiring touchtone capability. A new social contract was created; by encouraging the array of touchtone-related services, we will gather more freely and openly.[41]

But what if the switchover had involved a rate increase, thereby requiring rotary customers to join the information age, whether they wanted to or not? For instance, call messaging, call waiting, or call forwarding could be declared to be a *sine qua non* of universal service. Then what?

In short, as privacy or other features are added to the core of basic telephone service, costs rise. At the margin, some subscribers might drop off the network, failing to qualify or bother with the targeted subsidy programs. The consensus that has held for half a century about what constitutes basic phone service could break down as privacy costs are added to the bills of at least some who do not desire such features.

Elements of a Privacy Component for Universal Service

The author of a privacy plank in a universal service definition is thus faced with the twin realities that privacy imposes costs on all subscribers and that not all subscribers share the same solicitude regarding privacy in telephone conversations. Broad nostrums that, for example, "universal service must include protection of the privacy interests of individuals to the maximum extent possible," while polite sounding, hide the costs of such a policy as well as the lack of consensus when you get down to the details.

Instead, the decision to include a particular service as part of basic service, whether caller-ID or delisting of phone numbers in a directory, should be taken one by one. And in evaluating whether a particular service is a *sine qua non* of privacy in telephone service, the factors below should be considered.

Recognize the costs of privacy to the consumer. It bears repeating that privacy may impose costs, just as the lack of privacy reduces the feeling of autonomy and integrity that human beings should enjoy.

We make these sorts of cost-benefit analyses frequently in non-telephone privacy contexts. Hospital rooms are one example, but there are many others. Do I pay for tinted windows to keep people from peering into my car? Do I maintain a postal box address at an annual fee, or do I give out my residential address in exchange for having mail delivered to my residence for free?

The failure of communications policy to make the cost/benefit aspects of privacy rights explicit should be recognized and avoided. One example concerns cordless telephones. Currently federal law provides no explicit protection against eavesdropping of conversations made by cordless phones, and courts that have considered the question are divided.[42] Whether or not such conversations are subject to warrantless eavesdropping—I do not see why they should be—the cost of

securing the privacy of such conversations might make the cost of the highly practical cordless telephone out of reach of the large customer base it enjoys. A "privacy first" mentality dismisses the economic question too readily.

Impose costs on privacy violation initiators, where possible. The acceptance of the telephone into the household carries with it the expectation that there will be wrong numbers, unwanted sales calls, and other misdirected communications. Trespass laws prevent, to some degree, unwanted solicitors from entering another's private property, where solicitors are notified that they may not advance on the homeowner's premises. Sometimes, a well-illustrated "Beware of Dog" sign does the trick.

Until recently, the telephone system had no equivalent of a "No Solicitors" sign. With the advent of more sophisticated signalling systems, however, the telephone can become smarter in signalling who is calling: One ring if for me, two short rings if for my daughter.

Caller-ID provides a way to screen some unwanted calls. But because the number, not the name, is transmitted, unwanted telemarketers may succeed in getting through. One solution might be to require marketing organizations to be restricted to certain prefixes.[43] Customers could then block all telemarketing calls. Even this could evade detection, though: there are 900 services that permit callers to launder the phone number they are calling from by calling the 900 number first.

Another solution would be to require the telephone company to put an asterisk next to the name and number of every person who did not wish to receive unsolicited calls, with penalties meted out to those who called the number. This proposal was presented to the California Public Utilities Commission, which dismissed the idea in 1965, concluding that high costs and enforcement problems made the proposed system undesirable.[44]

That was then; this is now. With the advent of computer-driven telemarketing, the costs and benefits of the asterisk system—or its electronic equivalent, where an electronic "asterisk" is attached to a person's phone number—may need a second look. Congress has considered bills to create a criminal penalty for any solicitor who makes an unsolicited call to a number on a list of subscribers who have notified the phone company they do not want unsolicited calls.[45]

More generally, why should the telephone subscriber have to pay to be left alone from undesired telemarketers? The cost should properly fall on the invader, not the invaded. It could be argued that a resident has to prepare and affix the "No Solicitors" sign to enjoy the protection against trespassers. But the resident has the option of simply not opening the door or not responding to a knock.

It is impossible always to impose the costs of protecting against privacy invasion on the invader. If ever there was one, a lover's spat that ends with one hanging up on the other cries out for the right to be let alone. An immediate call back is often the worst of invasions of privacy. But a subtly timed call of apology may be most welcome. The apologizing party cannot be sure when the call shifts from the invasive to the desirable, and phone companies cannot be expected to develop pricing policies that reflect these subtleties of human behavior. The same cannot be said for telemarketers who as a class may be viewed as undesirable for some telephone subscribers.

And there is a flip side to telemarketing that deserves mention: shop-at-home services. When a party calls up for information from, say, a large mail order clothier, is the caller entitled to know that her number is being flashed to the operator, thanks to caller-ID? Is she entitled to know that her prior sales history, address, and other data are being made available?

There is the widely-reported story of American Express discontinuing answering phone calls from its members by using their names. With an ANI system tied to American Express business records, the information popped up on the phone operator's screen. Though the company operator still has that information flashing before him, he lets the caller identify herself.

But merely calling an 800 number has not been thought to be a waiver of personal information, at least not yet. Is there a duty on anyone "calling up" a caller's history during a sales call to disclose that practice by means of a disclosure or audible tone?

Recognize personal billing and CPNI as forms of personal publicity with a market value to the subscriber. Prosser's formulation of the four forms of privacy invasions has been criticized for including the fourth right, publicity, among rights that otherwise center on the right to be let alone.[46] But in the telephone context, the lines between publicity and privacy blur.

One subscriber may want any data collected about her calling behavior to be used only by the telephone company, and only for the direct purpose for which it is collected. Whom she calls is relevant only for purposes of assessing transport charges, not for developing a customer profile for marketing other services.

Another subscriber may have no objection to the use of data about calling behavior, so long as it is sold to others for purely marketing reasons and not, for instance, to verify that the subscriber was at a particular location at a particular time. A third subscriber may wake up each morning with nothing to hide and has no qualms about the use of calling information to bring new services to her attention.

As between the first and second subscriber in this hypothetical, there is a shift from an assertion of the right of privacy to the right of publicity. The first says, "Don't use it." The second and third say, "Use it." But all three subscribers would, however, probably prefer to be paid for the use of the data. Put another way, it is one thing for the phone company to collect data to go about its business of providing service. It is another, unrelated to the goal of universal service, to use collected data for commercial ends without paying for it.

The right of publicity has generally been limited to payment for a person's "name" or "likeness" in connection with a commercial exploitation. Noncelebrities enjoy this right; if *Spy* magazine uses my name in a direct mail campaign to my neighbors urging them to join me in subscribing, that would violate my right of publicity.

Until now, the sale of my name to mailing list companies only involves a negative right: I can prevent its use by writing to the publisher. But I do not get paid when the name and address are sold.

The degree of data collected by the telephone company about me is much greater than merely gathering my name and address. Would it not be valuable to know, say, that I spend $4 a month on 976-WAKE type services? Or that I have called the Eurail Pass office information line? (The reader is invited to cook up juicier examples.)

Depending on my sense of privacy, I would view the distribution of this data as either a problem or not. But even if I do not mind sharing this knowledge with the world, I would not want the telephone company (or anyone else) to profit from its distribution. Knowledge is not merely power, then; it is an asset of mine that should be recognized by those who would sell it.

Require periodic review of what is believed to be essential privacy in the telephone context. The great story of communications in this century has been the independent vector of technology. The development of packet switching by Paul Barron and others to handle bursty communications increased the efficiency of switches. So, too, did computer technology, which turned the clacking central offices of 40 years ago into quiet computer centers.

These developments made new forms of service, and new questions of privacy, inevitable. As Katz points out, "With the direct-dialing network of the past there was simply no practical way that callees could get information about callers prior to actually answering the telephone."[47] Today caller-ID is a technical reality, but the privacy questions as to the right of caller remain unresolved.[48]

More generally, as I have suggested, privacy—both as it concerns the right to withhold oneself from others and the right to control one's communications—is both a personal and an economic concept, in this latter case, privacy as sort of a property interest. Some aspects of privacy we assume no one must be required to relinquish; these are part of the guarantee of privacy found in the Penumbra of the U.S. Constitution. Other degrees of privacy invasion may occur, but at a price. Seclusion is less expensive in a rural county than in the borough of Manhattan. Those with servants and secretaries are buffered from whoever is at the door or on the telephone.

But drawing these lines at the margins is difficult. In less than 40 years, the Supreme Court reversed itself from *Olmstead* to *Katz* as to the privacy aspects of government wiretaps. Had human nature so fundamentally changed?

And who is best equipped to decide these questions? In 1980, the chairman of the FCC, Charles Ferris, was convinced that privacy would be a dominant communications issue of the 1980s. A senior staff retreat to Cool Font, West Virginia—a rarity in administrative annals—focused in part on how the FCC could bring privacy questions to the communications policy debate. Though much was considered, nothing came of that sylvan hand wringing.

We are well embarked on the 1990s and there is still no government apparatus at the FCC for considering privacy policy. A modest suggestion occurs: The FCC routinely considers (because it has to) matters like "regulatory flexibility"[49] and "paperwork reduction" in

every decision. Perhaps a tick-off category of "privacy impact," for a trial run of 24 months, would produce some provocative thinking on the privacy dimensions of communications policy.

Nor is the federal government the sole source of wisdom on these matters. One productive consequence of the various approaches to caller-ID by different states is to provide varied experiences with the technology. Of course, if there is a core privacy right implicated in caller-ID, there should be no difference in its treatment, state to state. But the process of defining the outer limits of the privacy right with a new technology will probably benefit by the various approaches taken by the states.

While consensus is hard, there should also be some effort to survey the public as part of the line-drawing effort. This is not always done. No one asked which is the privilege—to be listed in the telephone book or to be unlisted. One service is free, I get charged for the other. Privacy expectations surveys could be part of a phone company's showing in introducing new services and maintaining old ones.

This is not to advocate a "the more privacy, the better" philosophy. What surveys could show is consumer demand for privacy protections and the perceived value of services that provide them.

CONCLUDING THOUGHTS

There are more than 1,000 books and articles published on privacy and the exercise of privacy rights,[50] and I have not read even a small fraction of these. But I share Harry Kalven, Jr.'s view, at least as a legal matter, when he wrote:

> I suspect that fascination with the great Brandeis trademark, excitement over the law at a point of growth, and appreciation of privacy as a key value have combined to dull the normal critical sense of judges and commentators and have caused them not to see the pettiness of the tort they have sponsored.[51]

Mao Tse Tung and Jean-Jacques Rousseau saw the privacy interest as somewhat anathema to society's best interests. Putting aside the interests raised when government seeks to invade one's privacy, it is

worth asking this question, even if we know the answer: Is the right of privacy often an excuse for the right to behave in ways that we are otherwise ashamed of or too shy about? And, more pertinently, who should bear the costs that insistence on a particular level of privacy imposes?

It has been said that one person's freedom ends at the tip of another person's nose. The other person's wallet is not a bad place to consider drawing the line, either. Suppose a husband wants to have an affair and lie to his wife by claiming that he's at the office when he's at his girlfriend's house. He'll need to block the call. Ordinarily, 'taint my business. But suppose he prevents the economic deployment of caller-ID in the name of "privacy" by insisting on this call-blocking feature. And suppose that the deployment of blocking costs my grandma (who wants caller-ID to stop harassing calls) 50 cents more a month. Then his definition of privacy *is* my business.

In other words, is it fair to impose the costs of enforcing privacy rights on all through privacy guarantees as part of the definition of universal service? The answer to this question could be helped by periodic surveys of the public regarding privacy. These will not answer all of these questions, of course. Denying vital privacy interests to unpopular groups, e.g., incarcerated individuals, should not be based on informal plebiscites. And matters such as secret ballots, warrantless government wiretaps, and trespass into the sanctity of the home should not be subject to this survey-oriented characterization of the privacy right.

Further, given the complex and deregulated environment of telephone pricing, the foregoing cost-benefit analysis may be impossible. But by asking questions about privacy in direct ways, and in emphasizing the cost of privacy, phone companies and regulators—who may ultimately decide the cost and nature of services—will, it is hoped, have a better handle on the question.

Privacy is one of the profound civilizing values of a society. The ability of the telephone to disturb our privacy in new, annoying, and unexpected ways gives reason enough to consider privacy as part of the definition of universal phone service. At the same time, telephone privacy can impose costs on all users when it is part of that definition. Arriving at these costs is a needed step in formulating the privacy plank of a doctrine of universal service.

ENDNOTES

1. One of the leading writers in this field is James Katz, who works for Bellcore, to whom the author is indebted for his expert writings and helpful conversations.
2. See generally Brock, G., *The Telecommunications Industry*, 1981, pp. 158–161; and G. Faulhaber, *Telecommunications in Turmoil*, 1987, pp. 1–21.
3. Paine, A., Theodore N. Vail, *A Biography*, 1921. The first reference to the universal service concept appears in AT&T's 1910 annual report.
4. One finds a trace of the universal service idea in §151 of the Communications Act. There Congress stated as one of the goals of the act, "to make available, so far as possible, to all the people of the United States a rapid, efficient, Nation-wide, and World-wide wire and radio communications service with adequate facilities at reasonable charges." 47 U.S.C. §151, 1988.
5. *FCC Monitoring Report*, January 1991.
6. Amendment of Commission's Rules to Establish New Personal Communications Services, Notice of Inquiry, General Docket No. 90-314, 5 FCC Rcd. 3995, 1990.
7. O'Toole, G., *The Private Sector*, 1978, p. 97.
8. *Olmstead v. United States*, 277 U.S. 438, 1928.
9. *Id.*, p. 478 (Brandeis, J., dissenting).
10. *Whalen v. Roe*, 429 U.S. 589, 1977.
11. Westin, A.F., Privacy and Freedom, 1970. See H.M. Proshansky, W.H. Ittelson, and L.G. Rivlin, eds., *Environmental Psychology 178*, 1970; J.R. Pennock and J.W. Chapman, eds., *Privacy*, 1970.
12. *Los Angeles Times*, September 5, 1991, p. D1.
13. Barasch, David M., *Consumer Advocate v. Pennsylvania Pub. Util. Comm'n*, N. 2270 C.D., 1989 (Commonwealth Ct. May 30, 1990—use of caller-ID is illegal and unconstitutional under Pennsylvania state law, which is modeled on the federal law).
14. Katz points out that a caller concerned about this invasion of privacy has a number of options to hide his identity from callees: using a pay telephone; telephoning from an unexpected location; using an operator assist within some switching architectures; having two phone lines, one used exclusively for dialing out; using a cellular or mobile telephone; or using a per-call block of calling number delivery. Katz, "Caller-ID, Privacy and Social Processes," *Telecommunications Policy*, October 1990, pp. 372, 383.
15. Per-*line* block allows a caller's number to be delivered only if the caller affirmatively takes steps to allow it (by pressing an extra code on the telephone after dialing the callee's number). Per-*call* block allows the caller's number to be delivered unless an extra code is dialed after dialing the outgoing number to prevent this. California requires caller-ID to be deployed with per-call block. New Jersey allows caller-ID to deliver the caller's number under all circumstances. Experts divide on the privacy effects of caller-ID. James Katz of Bellcore believes that caller-ID increases privacy rights for citizens, focusing on the callee's rights. Gary Marx and Oscar Gandy, Jr., believe that caller-ID violates privacy expectations of callers and should be declared illegal.
16. The Telephone Privacy Act of 1990 would have required a telephone company that offers caller-ID to provide the calling party with the option of restricting the

representation of the phone numbers, i.e., per-call or per-line blocking: Hearing Before the Subcommittee on Courts, Intellectual Property, and the Administration of Justice of the Committee on the Judiciary, H.R. 4340, September 19, 1990.

17. U.S. Constitution, Amendment IX: "The enumeration in the Constitution, of certain rights, shall not be construed to deny or disparage others retained by the people."
18. 381 U.S. 479, 1965. Judge Clarence Thomas indicated a 14th Amendment right to privacy in his Senate confirmation hearings for a seat on the Supreme Court. Others have identified the First and Fourth Amendments as sources for the right of privacy.
19. Katz and Tassone, "Poll Report: Privacy and Information Technology," *Public Opinion Quarterly 54*, 1990, pp. 125, 130. A 1990 Louis Harris and Associates survey, *Consumers in the Information Age*, found that a majority of people think their right to privacy is in jeopardy.
20. Warren and Brandeis, "The Right to Privacy," *Harvard Law Review 4*, 1890, p. 93.
21. Katz cites the observation of John Carey of Greystone Communications: "Railroad flats of older cities like Philadelphia, which are still standing in some cases, had apartments arranged so that one had to walk through one or two other apartments in order to reach the third." Katz, *supra* note 14, p. 374.
22. Prosser, "Privacy," *California Law Review 48*, 1960, p. 383.
23. Nicholas Johnson, not entirely facetiously, informs telemarketers that he charges a $10 fee for the privilege of making their sales pitch. Discussion, The Aspen Institute, Queenstown, MD, July 25, 1991.
24. By the mid-1970s a common law of privacy was recognized in 36 states. Since then, Connecticut and West Virginia have adopted Prosser's four torts of privacy. North Carolina rejected the "false light" tort of privacy. Minnesota rejected any common law form of privacy rights, and New York has adopted that approach. See J.T. McCarthy, *The Rights of Publicity and Privacy*, May 1991, pp. 6-4 to 6-5.
25. See, e.g., 47 C.F.R. §1.77(g).
26. 277 U.S. 438 (1928). "[N]o person not being authorized by the sender shall intercept any communication [or] divulge . . . the . . . contents [thereof] . . . to any person." 47 U.S.C. §-705, 1988.
27. 388 U.S. 41, 1967.
28. 389 U.S. 347, 1967.
29. 18 U.S.C. §§2510-2520, 1988.
30. See Note, "The Admissibility of Evidence Obtained by Eavesdropping on Cordless Telephone Conversations," *Columbia Law Review 86*, 1986, pp. 323, 332–334.
31. *Id.*, pp. 333–334.
32. 442 U.S. 735, 1979.
33. 18 U.S.C. §2510, 1988.
34. *Id.*, §-3121(a). A trap and trace is defined as a "device which captures the originating electronic or other impulses which identify the originating number of an instrument or device from which a wire or electronic communication was transmitted." *Id.*, §-3127(4).
35. Fair Credit Reporting Act, 15 U.S.C. §1681, 1988.
36. Family Educational Rights and Privacy Act, 20 U.S.C. §-1232(g), 1988.
37. Rights to Financial Privacy Act, 12 U.S.C. §-3401, 1988.

38. Cable Communications Policy Act, 47 U.S.C. §-551, 1988.
39. Video Privacy Protection Act, 18 U.S.C. §-2710, 1988.
40. Subscriber line charges, recommended by a federal-state joint board, are monthly charges paid by every telephone subscriber for the use of local loop facilities to make long distance calls.
41. And the switchover has privacy implications as well. The policy change means that subscribers will be more, not less, likely to assemble electronically. Not only can subscribers who previously might not have been able to participate in touchtone activities do so, they can be expected to do so. For instance, a person may now be required to use touchtone menus of service and not be given the option to "wait for an operator to assist" them. Callers may find that they no longer determine their own speed but must choose from options set by the electronic menus. Query whether these policy considerations entered the touchtone debate.
42. Compare *United States v. Hall*, 488 F.2d 193 (9th Cir. 1973—evidence from mobile telephone conversation inadmissible when one party used a conventional telephone) with *Kansas v. Howard*, 235 Kan. 236, 679 P.2d 197, 1984, and *Rhode Island v. Delaurier*, 488 A.2d 688 (R.I. 1985—cordless phone conversations not protected).
43. This is suggested in Katz, "U.S. Telecommunications Privacy Policy: Socio-political Responses to Technological Advances," *Telecommunications Policy*, December 1988, pp. 353, 364. See also Royal, "Constitutionally Regulating Telephone Harassment: An Exercise in Statutory Precision," *Chicago Law Review 56*, 1989, p. 1403. For a discussion of the telemarketer's freedom of speech see Nadel, "Rings of Privacy," *Yale Journal on Regulation 3*, 1986, p. 99.
44. *McDaniel v. Pacific Tel. & Tel. Co.*, 60 Pub. Util. Rep. (PUR) 47, 1965.
45. S. 2193, 95th Cong., 1st Sess., 123 Cong. Rec. 33, 1977, pp. 371-72. A number of bills have sought to regulate automatic-dialing recorded-message players. See Note, "Regulation of Unsolicited Telephone Calls: An Argument for a Liability Rule," *Computer/Law Journal 5*, 1985, pp. 393, 397 n.34.
46. Nimmer, "The Right of Publicity," *Law & Contemporary Problems 19*, 1954, p. 203.
47. Katz, *supra* note 14, p. 376.
48. Laurence Tribe has raised a similar question as to an individual right to minimum computing power: "It's true that certain technologies may become socially indispensable—that the equal or at least minimal access to basic computer power, for example, might be as significant a constitutional goal as equal or at least minimal access to the franchise, or to dispute resolution through the judicial system, or to elementary and secondary education." "The Constitution in Cyberspace: Law and Liberty Beyond the Electronic Frontier," speech before the First Conference on Computers, Freedom, and Privacy, March 24, 1991.
49. 5 U.S.C. §603(a), 1988.
50. *Id.*, p. 374 n.10.
51. Kalven, Harry, Jr., "Privacy in Tort Law—Were Warren and Brandeis Wrong?" *Law & Contemporary Problems 31*, 1966, p. 326.

TECHNOLOGIES OF UNIVERSAL SERVICE

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INTRODUCTION

For more than half a century, universal service has meant widely available, affordable, high-quality voice telephone service. Now, the advent of a wide range of new telecommunications technologies, including fiber optic cable, computer hardware of growing speed and power, software for switching and encryption, and increased ability to allow conversations over long distances without wire, offer the prospect of an expansion of universal service. Two-way video delivered to the home is no longer the stuff of science fiction but of business plans, and the "personal telephone" tied to an individual rather than a location is a near-term likelihood.

These new technologies have prompted the reconsideration of the nature of universal service that is the purpose of this volume. This paper focuses especially on the technological underpinnings of universal service in an attempt to answer the question, What might constitute universal service in the 21st century?

One way to answer this question is to examine the ways in which a range of different technologies became universally available, or nearly so. Section 1 adopts this approach and uses the diffusion of innovation model to focus on the slopes of the curves that describe penetration of several telecommunications technologies. Analysis of differences in

the slopes suggests that technologies that comprise a wired infrastructure, such as telephone or electricity, are adopted according to patterns that differ from technologies that do not require wire or that come on line after the infrastructure is already widely available.

Once we differentiate networked and interactive technologies, moreover, it becomes evident that the diffusion of innovation model does not help answer many of the most important questions about universal service; for example, When is a service "universal" and how can we help it become universal? By examining, in Section 2, the essential features of a universal service—interactivity, widespread access, and equity—we can see that a model such as diffusion of innovation, which relies primarily on individual choice through the marketplace to determine access to new technologies, cannot easily account for a public role. Rather, the way in which a networked interactive technology becomes woven into the very fabric of its society makes universal service inherently public and, therefore, requires some public decision making. A review in Section 3 of four of the many possible forms of universal service highlights some of the choices our society faces and suggests that achieving true universal service will depend upon deliberate selection of a collective approach. Thus the paper is a call to action as well as a review of technologies that might expand our concept of universal service.

SECTION 1
WIDESPREAD TECHNOLOGIES AS UNIVERSAL SERVICE

Because those who neglect the past are doomed to repeat its mistakes, we begin by reviewing the history of technologies that became universally available. Heretofore, most analysts have used the diffusion of innovation model to confirm that innovations are adopted according to a relatively standard pattern. Comparing rates of adoption of several technologies suggests, however, that technologies that rely upon a network and constitute infrastructure are adopted more gradually than others. Networked technologies can only spread incrementally, as each part of the network must branch from an existing part, while those subject only to individual choice may be adopted almost simultaneously by many people. Once we recognize that networked technologies differ in this important way, it becomes clear that they differ in other ways as

well: Adoption requires more than an isolated decision by an individual, and the technologies occupy the shared resources of the community. In other words, networked technologies have an inherently public nature. The diffusion of innovation model is not designed to explain the adoption and spread of such technologies, which have always relied upon public intervention and often upon direct subsidy for their ultimate success. In looking to the future of universal service, therefore, one important lesson to draw from the past is the importance of non-market mechanisms in ensuring widespread and equitable access to infrastructure technologies.

The diffusion of innovation model postulates that knowledge of an innovation is communicated through certain channels over time among the members of a social system.[1] Thus a few innovative people adopt a new technology or idea and by their words and actions cause others in their societies to follow suit. Because each additional individual who adopts the new technology has more contacts, the rate of adoption can be predicted to increase geometrically. In fact, the diffusion of innovation model generally predicts an S-shaped diffusion curve: a period of relatively slow adoption, a "take-off" characterized by much more rapid adoption, and a final period of slow accretion as the last few holdouts finally begin to use the new technology.

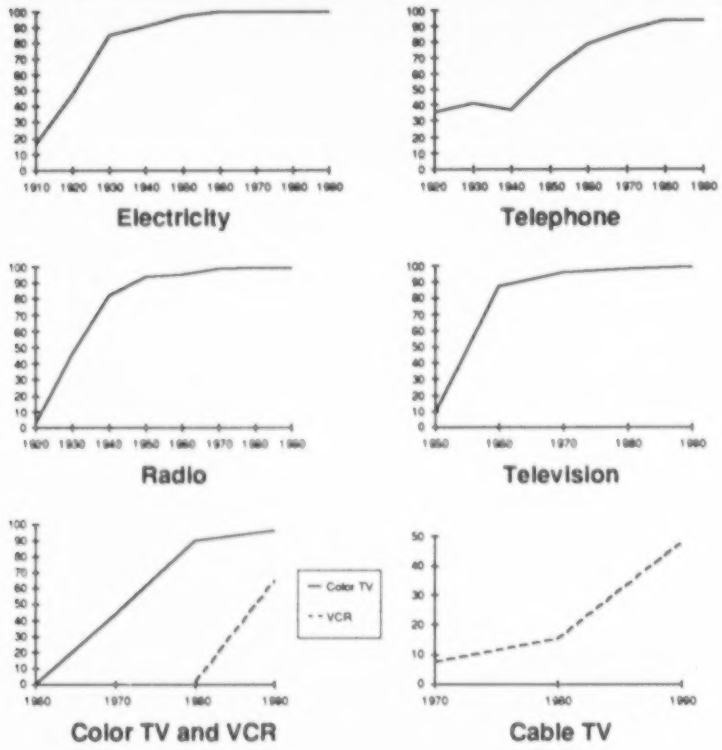
Examining the patterns by which earlier successful telecommunications technologies diffused through society provides a first step in understanding the nature of past universal service. Table 1 describes the

Table 1 Percent of Households with Different Technologies

Year	Elect'y	Phone	Radio	TV	Color TV	Cable TV	VCR
1900							
1910	15.9						
1920	47.4	35.0	1.6				
1930	84.8	40.9	45.8				
1940	90.8	36.9	81.5				
1950	96.6	61.8	93.4	8.9			
1960	99.5	78.3	95.1	86.6			
1970	99.6	87.0	98.6	95.3	43.0	7.5	
1980	99.8	93.0	99.0	97.9	90.0	15.2	1.1
1990	99.8	93.0	99.0	99.0	96.0	48.0	64.6

Source: See sources for Figure 1.

Figure 1 Percent of Homes with Various Technologies



Sources:
Electricity (data for 1960 and later include Alaska and Hawaii): U.S. Census, *Historical Statistics of the United States*, Part 2. Washington, DC: GPO, 1976. Table 108-119, p. 827.
Telephone: Ibid. Table R 1-12, p. 783.
Radio (through 1970): Calculated by author from data in Ibid. Table R 93-105, p. 796. Later data from U.S. Census, *Statistical Abstract of the United States, 1990*, Table 914, p. 550.
Television (through 1970): Calculated by author from data in *Historical Statistics*, Table R 93-105, p. 796. Later data from *Statistical Abstract, 1990*, Table 914, p. 550.
Color TV and VCR: *Statistical Abstract, 1990*, Table 914, p. 550.
Cable TV: *Statistical Abstract, 1990*, Table 914, p. 550.

percents of households with different technologies over the course of this century, and Figure 1 provides the same information graphically. Note that, in many cases, the left-hand tail representing slow initial

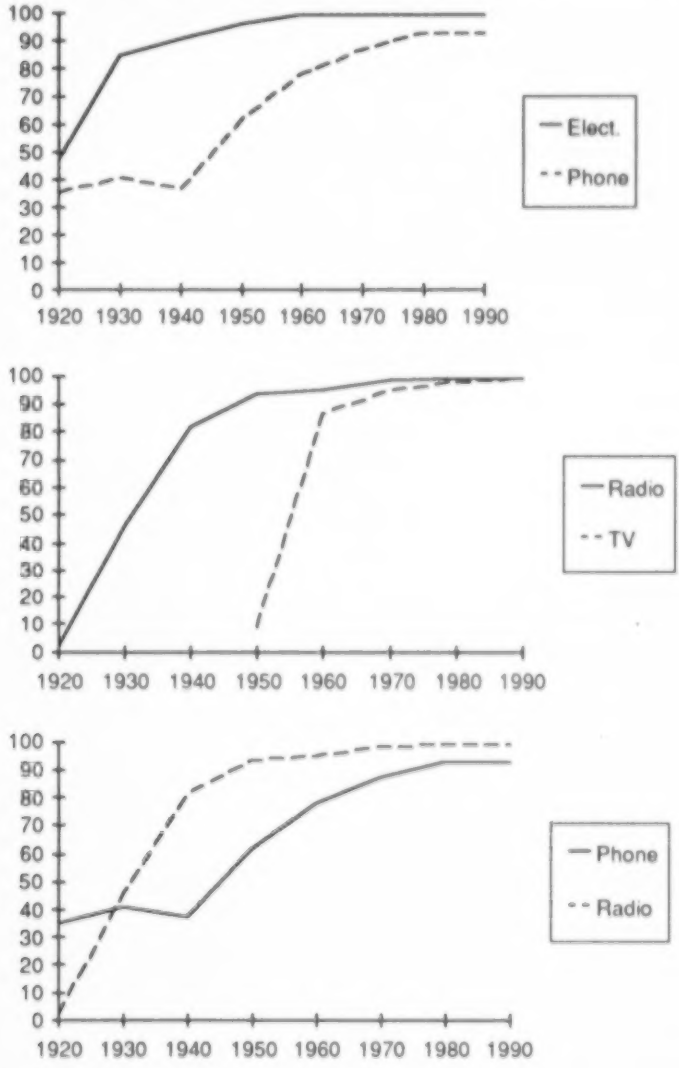
adoption is not clear in the data presented here due to the absence of readily available data in a form comparable to the later data. The overall shapes that are apparent are, however, sufficient for our present relatively modest analytical purposes.

Although the data generally follow the predicted pattern, the different technologies evince quite different patterns of take-off. For example, as Carey and Moss have shown, the telephone took more than 70 years to penetrate to half of American households, while the radio took only 10. VCRs appear to have had a swifter adoption rate than cable. Video games had reached more than one-fourth of U.S. households within 10 years of being available, while personal computers had reached only 15 percent in the same amount of time. Growth rates differ even more widely: the telephone grew at an average rate of 80 percent over the first five years; black-and-white TV at a rate of 320 percent.[2]

One reason for these different patterns may be their different technological features. For example, delivery of telephone services to the home required installation of a new wired infrastructure, while TV and radio did not. Conversely, TV and radio required a one-time purchase by the customer, while telephone service required both an initial one-time connection fee and a continuing monthly payment. Can the different rates of diffusion of the technologies be attributed to these differing features? Figure 2 shows some of the diffusion curves superimposed as a partial attempt to answer this question.

To refine our understanding of the information in the graphs, Table 2 displays the average slopes of the curves over a decade. The larger the number, the steeper the slope—that is, the more rapid the diffusion of the technology during that decade. The table and graphs suggest that adoption of what we may very loosely call "post-infrastructure" technologies—those that draw on existing connections and wires to homes—occurs at a more rapid rate than for the three technologies that require new wiring—electricity, telephone, and cable TV. While the slope in the three wired technologies never exceeds 3.7, it rises as high as 7.8 for black-and-white television and 6.4 for VCRs. Reasons for this difference are not difficult to find: Individuals cannot adopt wired technologies until the network has "passed by" their homes, and the building of a network must by definition be incremental. The more gradual rate of diffusion is thus built into the technology itself.[3]

Figure 2 Percent Comparisons of Adoption Rates for Different Technologies



Source: See sources for Figure 1.

Table 2 Slopes of Diffusion Curves (Avg. Annual Adoption Rate)

Year	Elect'y	Phone	Radio	TV	Color TV	Cable TV	VCR
1910–20	1.6	0.0	0.0	0.0	0.0	0.0	0.0
1920–30	3.2	3.5	0.2	0.0	0.0	0.0	0.0
1930–40	3.7	-0.6	4.4	0.0	0.0	0.0	0.0
1940–50	0.6	2.5	3.6	0.9	0.0	0.0	0.0
1950–60	0.6	1.7	1.2	7.8	0.0	0.0	0.0
1960–70	0.3	1.0	0.2	0.9	4.3	0.8	0.0
1970–80	0.0	0.6	0.4	0.3	4.7	0.8	0.1
1980–90	0.0	0.0	0.0	0.1	0.6	3.3	6.4
Number of decades of steep adoption (slope 2.5 or more)	2	2	2	1	2	1	1

Source: See sources for Figure 1.

Having induced from the data on diffusion of successful telecommunications technologies the hypothesis that networked technologies differ systematically from others, we ask whether this hypothesis makes sense—that is, why it might be true. The physical nature of the network—the fact that each part must branch from an existing part—is one important factor. Deriving from this feature is a second: Adoption of a networked technology requires more than an isolated decision by a single individual. Instead it requires that the network pass close enough to be available, which is a result of decisions by many other individual users as well as by the builder of the infrastructure.

This feature in turn calls attention to a third characteristic of networked technologies that helps to account for their relatively slower rate of diffusion: They are a "shared resource of a public community."[4] This characteristic in some sense accounts for the other two, because it is this call on the community's shared resources that makes it impossible for the technology to be adopted solely at the volition of individuals. One way in which networked technologies use community resources is purely physical: They require installation of utility poles or underground conduits that occupy space in both public and private rights-of-way. The Post Roads Act of 1866 granted telegraph companies permission to use rights-of-way in roads and across public lands and to use for free the trees on public lands for poles. Governmental grants of public lands for rights-of-way continued throughout the 19th

and 20th centuries, aiding in the growth of infrastructural technologies ranging from railroad to telephone to cable. Less tangible but still community-based aspects of networked technologies are considered in more detail in Section 2.

In short, the same features of a network that dictate its different pattern of diffusion also make it at least partly public in nature. A network cannot grow without the tolerance or support of the public. To the extent that the future of universal service is tied to one or more networked technologies, it is also public.

Although the future of universal service may differ from its past in significant ways, this brief review of past telecommunications technologies diffusion provides three useful insights into any form of universal service. First, universal service broadly defined has changed over time as new technologies have become available. An "average" household in 1990 has very different expectations about which technologies will be readily available than did a similar household in 1940. Second, technologies clearly diffuse in different ways. Comparing the slopes of the diffusion curves suggests that there may be a fundamental difference in diffusion patterns of technologies requiring a new wired infrastructure and those that are introduced after the infrastructure is in place. More refined methods of comparing slopes of diffusion curves and consideration of individual rates of adoption once a network has passed by certainly merit additional research.[5]

Third, this review highlights the limitations of a model in which individual choice is the driving force. By distinguishing between technologies requiring new networked infrastructure and those that can be adopted largely on the basis of individual choice, the present analysis has suggested that social forces may be as important as individual ones in diffusion of certain technologies. Even the extension of the classical diffusion of innovation model into organizations—a refinement that reflects a new understanding of the importance of organizations, including governments, in adopting and disseminating new technologies—focuses on the organization as a single actor and does not fully capture the idea that some technologies (especially those that require installation of a new infrastructure and those that are interactive) are inherently social in nature. As we shall see in the next section, a technology intended for universal service is by definition such a social or public technology.

SECTION 2
UNIVERSAL SERVICE: A VISION, NOT A TECHNOLOGY

The discussion in Section 1 considered all communications technologies as potential "universal services," and even included electricity, a non-communications technology whose wired nature makes it a likely comparison for telephone service. Yet the term universal service has, virtually since it was coined, applied to the widespread availability of basic telephone service, not to that of radio or VCRs. Telephone service became the focus of interest in large part because it provided one feature unavailable through any other technology of the day: interactivity. This feature offered important benefits, both tangible—increased efficiency of workers and greater radius for business contacts[6]—and intangible—less sense of fear and isolation among farmers and their families and increased sense of community for both rural and urban dwellers.[7] Because the full benefits of interactivity are not available unless most people participate, the idea of universal service also came to incorporate equity, which in turn required both uniform quality and reasonable cost for service. These features are clearly mentioned in the preamble to the Communications Act of 1934, which calls for government regulation

> to make available, so far as possible, to all people of the United States a rapid, efficient, nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charge.

The following discussion reviews the historical development of the idea of universal service, focusing on its essential characteristics: interactivity, widespread availability, and equity. These are the very features least well adapted to inclusion in the traditional diffusion of innovation model, however, and in each section I will elaborate on the contention that the diffusion of innovation model limits our understanding of problems associated with future expansion of universal services. These criticisms are summarized in the concluding part of this section, which suggests that collective decision making is a *sine qua non* of universal service.

Connectivity and Interactivity

From its outset, universal service has been a vision of the way a technology should operate in society, not merely a description of the extent to which technology has diffused through it. The essential feature of universal service has been a degree of connectiveness that promotes interactivity. In a letter to a group of British investors just two years after he invented the telephone, Alexander Graham Bell wrote:

> At the present time we have a perfect network of gas pipes and water pipes throughout our large cities. We have main pipes laid under the streets communicating by side pipes with various dwellings, enabling the members to draw their supplies of gas and water from a common source.
>
> In a similar manner it is conceivable that cables of telephone wires would be laid under ground, or suspended overhead, communicating by branch wires with private dwellings, counting houses, shops, manufactories, etc., uniting them through the main cable with a central office where the wire could be connected as desired, establishing direct communication between any two places in the city.[8]

Bell's vision of widespread interconnection went beyond the analogy of the pipes, moreover. The first switchboard, developed in New Haven in 1878, was purportedly an accident: The licensee ran all wires through his office for ease of servicing. When Bell received a letter describing it, he said he had always anticipated this development, which was central to his idea of the role of the telephone in society. Similarly, when the automatic exchange was invented in 1892, Bell wrote that it would "so reduce the expense that the poorest man cannot afford to be without his telephone."[9]

For Theodore Vail, who brought the term into widespread use, universal service was also a vision. In his famous paragraph in the AT&T annual report for 1910, Vail wrote:

> The Bell system was founded on broad lines of "One System," "One Policy," "Universal Service," on the idea that no aggregation of isolated independent systems not under common control, however well built or equipped, could give the country

> the service that an interdependent, intercommunicating, universal system could give. One system with a common policy, common purpose and common action; comprehensive, universal, interdependent, intercommunicating like the highway system of the country, extending from every door to every other door, affording electrical communication of every kind, from every one and every place to every one at every other place.

Vail not only had a vision but contrived to further it through a bargain with regulators. He believed that the primary goal of universal intercommunication and interconnectivity could only be achieved through a single system with uniform standards for the network and related equipment, and in return was willing to accept governmental oversight.

As we consider the future of universal service, it is important to remember the extent to which both Bell and Vail and their visionary successors believed that the essence of universal service was connectivity and the ability to interact with others. Both saw the telegraph's ability to reduce distance as a great achievement and wanted to duplicate it or even transcend it through the medium of the telephone.[10] For a while in rural areas, the telephone network, of very low quality and limited interactivity, was used primarily to obtain information about the weather and crops; the advent of the radio actually caused a reduction in telephone use because of its superior quality for these purposes.[11] When better-quality telephone service became available, however, it transformed rural life, reducing its isolation and boredom in a way that the radio never could.

Other commentators have shown that the diffusion of innovation model, with its focus on individual choice, is not entirely appropriate for study of interactive technologies. Markus argues that the sequential nature of the diffusion model, in which early adopters are imitated by others or successfully persuade others to follow, is not an accurate description for interactive technologies.[12] Instead, she believes, interactive technologies are characterized by reciprocal interdependence, since even early adopters will abandon an interactive service that others avoid, recognizing that they will never capture its full effect. Moreover, benefits to early adopters are unusually low, reflecting the absence of many others with whom to interact, so adoption is extremely gradual at first but becomes very steep after some critical mass is reached.[13]

Interactivity thus changes both the pattern by which a technology is adopted and the social institutions needed to bring it to full efficacy, because early adopters bear relatively higher costs and obtain lower benefits than they would in the case of non-interactive technologies.

Passive receipt of information is a very different activity from active participation in seeking it out, providing it, and exchanging it. As we look to future redefinitions of universal service, the notion of interactivity must remain paramount. However, interactivity is of dubious value without widespread access, the next feature of universal service we must consider.

Universality of Service

Figure 1 illustrates the rate of penetration (or adoption) of several telecommunications technologies. These graphs and others that derive from the assumptions underlying the diffusion of innovation model do not—indeed, cannot and were not intended to—help us determine when a technology has become "universal." That determination is a policy choice. Do we have universal service with a telephone penetration rate of about 93 percent of households? Most people do accept this as universal, although it certainly palls in comparison with the universality of television, with a 99-percent penetration rate. Would we consider a service or technology universal if it were present in 85 percent of households? Eighty percent?

A descriptive model cannot answer these questions, although it may be tempting to regard a technology as universal when the adoption rate begins to trail off following the rapid rise characteristic of the middle portion of an adoption curve. In other words, when the S-curve starts to flatten out, an observer might argue that "almost everyone" has adopted the technology and that it is acceptably universal in scope. But even the rough figures provided above show that this flattening out occurs when different portions of the population have adopted a technology: less than 90 percent for telephone and about 98 percent for radio and electricity.

Wired technologies give rise to a related concern. Should a service be considered universal if it is *accessible* to all, or only if it is *used* by all? Although some 82 percent of homes are passed by for cable TV, only about 48 percent actually use the service.[14] The former number suggests a nearly universal level, while the latter presumably does not.

Here the reader may protest that this is not a question applying only to infrastructural technologies. Compact discs (CDs), for example, are really universally available, since all anyone has to do is walk into a store and buy one. By this definition, any product on the market is "universal" because of its widespread availability, even when it is not universally used. This example shows that our intuitive definition of universality requires adoption and use, not just availability. For such interactive technologies as telephone, use is especially important because the benefits of the network depend in large part upon the number of active participants. Thus mere availability is not an indication of universality.

Ironically, the term *universal service* as it applies to plain old telephone service has usually been taken to mean accessibility. The widespread availability of the network is thought to be sufficient, since even people without telephones in their homes often have access in other ways. Indeed, the U.S. census includes a question asking whether members of a household can be reached through a telephone not on the premises (see Table 3). Pay telephones were regarded from the very earliest days as an important means for allowing access to the network by people without telephones in their homes.[15] Pay telephones do not constitute a viable alternative to a telephone in the home, however, as they are in some sense one-way communications tools; the caller must initiate the contact and cannot be reached with the same convenience as a person with a telephone in the home. Moreover, with deregulation, the presence of pay telephones in poor neighborhoods has declined and the quality of those remaining, especially in bars and laundromats, has also decreased.

The pernicious effects of not participating in a service that others regard as universal are clear. The Montana Supreme Court held that lack of a telephone is a significant "barrier to employment,"[16] a point also made in a cartoon showing a bedraggled person hearing from a potential employer, "We'll fax you when we're ready for you to start work." Another illustration is found in the fact that lack of a telephone contributes directly to termination of winter heating: Utility staff could not contact household members to warn them of the pending disconnection and household members could not contact the utility or social service agencies to resolve the crisis.[17]

Thus universality, especially for interactive services, goes well beyond access to include real participation. Participation, in turn,

Table 3 Telephone Penetration in Selected States, 1990 Average

State	Telephone Penetration	
	*Unit**	*Availability**
U.S. Overall	93.3	95.0
New Mexico	85.8	89.5
Mississippi	87.6	90.3
West Virginia	87.6	91.7
Arkansas	88.7	91.9
Kentucky	89.1	93.3
Washington, DC	91.4	93.2
New York	91.9	92.8
California	94.6	95.5
Pennsylvania	96.9	97.6
Hawaii	95.3	96.8
Minnesota	96.9	98.1
North Dakota	97.0	97.9
Connecticut	97.1	97.7

* Unit represents percent responding positively to the presence of a telephone in the house or apartment. Availability represents a positive response to either presence in the home or a telephone elsewhere on which people in the household can be called.

Source: Alexander Belinfante, "Telephone Subscribership in the U.S.," Washington, DC: Federal Communications Commission (Industry Analysis Division, Common Carrier Bureau), February 1991, Table 2, p. 14.

requires having the service available in the home, not somewhere down the street, because the service must be usable while the baby is asleep or dinner is cooking, and for emergencies people must be reachable even in the middle of the night. In short, universal service is closely related to the idea of necessity. As early as 1933, experts investigating social trends at the request of President Hoover concluded that the telephone was

> not . . . a luxury or a desirable convenience, but . . . a necessity. The disadvantages of not having the telephone close at hand are so great that it is installed even where the total number of calls may be relatively few. The telephone directory has assumed importance as a city directory and is useful in establishing contact. To be without a telephone or a telephone listing is to suffer a curious social isolation in a telephonic age.[18]

This statement is perhaps even truer today than it was 60 years ago, but it is not the kind of analysis that could be obtained from data on penetration of technology or the rate at which innovation has been adopted. Thus the definition of universality is more social than technological—a matter of values rather than of data. This limitation of the diffusion of innovation model is even more striking when we consider another central feature of universal service: equity.

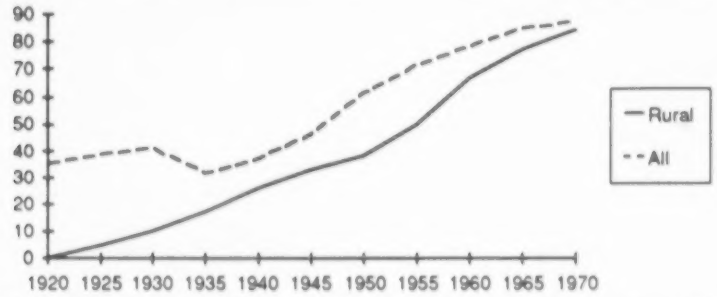
Equity

In its application to universal service, equity is a broad term. Historically, the emphasis was on geographic equity. In AT&T's annual report for 1909, Theodore Vail wrote that the telephone must be made available in "territory which is not, and may never become, profitable in itself, but must be carried at the expense of the whole."[19] That is, using its (perhaps excessive) profits from densely-populated areas or high-end services, a monopoly could subsidize other places or kinds of service that would otherwise be unprofitable. The system of cross-subsidies that kept the cost of local telephone service low was ratified as part of the regulatory bargain AT&T worked out over the years with the relevant state and federal regulatory bodies. In 1930, the Supreme Court clarified this issue, holding that some of the costs of providing local service should be allocated to long-distance rates.[20] The ensuing structural readjustment in rate setting reduced basic telephone tariffs to the point at which they were affordable for most Americans.

From these early times, the most obvious and striking problem of equity thus concerned rural areas. The costs of delivering service were much higher, both relatively and absolutely, because of the low population density, long distances, and roughness of terrain. Figure 3 shows that access to telephones in rural areas lagged well behind that in urban areas until around 1970, three-quarters of a century after the telephone was first introduced.

Even though early concern focused on geographic neutrality, in 1934 the Communications Act publicly acknowledged two other important forms of equity: uniformity of service quality ("adequate service") and "reasonable cost." Both goals reflect Congress' usual distaste for the specific, leaving analysts room for some disagreement about whether they have been achieved. Arguing solely from the diffusion of innovation data displayed in Section 1, it would appear that

Figure 3 Percent of Households with Telephone, Overall and Rural Only



Source: See Figure 1 for overall. Rural data 1940 onward from National Telecommunications and Information Administration, *NTIA Telecom 2000: Charting the Course for a New Century*. Washington, DC: U.S. Department of Commerce, October 1988, p. 643. Data from 1920 to 1940 is extrapolated.

the cost of telephone, radio, television, and, increasingly, VCRs and cable, are all "reasonable" because such large portions of the population have adopted them. However, as a service takes on the status of a "necessity"—and we have just argued that the telephone is a necessity—price elasticity of demand decreases, meaning that people will pay even "unreasonable" prices to obtain it. The more disaggregated data of Tables 3 and 4 suggest that some people find the present price of telephone service unaffordable.

Readers may take very different approaches to the information in these tables. Perhaps the differences shown here are acceptable, reflecting both cultural and regional preferences as well as the unfortunate but inevitable consequences of very low income. On the other hand, these data (and others not presented in the table) may be interpreted as showing that telephone service is not really universal, but only universal for middle- and upper-income Americans living in multi-person households headed by someone over 30 years of age.

In either event, it is clear that the data concerning diffusion of the technological innovations discussed in Section 1 give unwarranted uniformity to a picture that is actually characterized by considerable diversity, with age, sex, income, geography, and race all related to the actual level of access. The historical data appear to show that if we wait long enough, relying upon the seemingly natural and inevitable forces

Table 4 Percent Families with Telephone by Race and Income, 1990 Average

Annual Income	Total	White	Black	Hispanic
< $5,000	75.4	79.1	66.1	61.9
5,000– 7,499	82.6	84.9	74.9	66.7
7,500– 9,999	86.9	89.0	77.3	74.8
10,000–12,499	88.9	90.2	81.9	74.7
12,500–14,999	91.7	92.7	85.9	82.0
15,000–19,999	93.3	94.2	87.7	85.1
20,000–24,999	95.6	96.1	91.9	89.4
25,000–29,999	97.0	97.7	90.9	94.2
30,000–34,999	97.0	98.4	93.3	96.0
35,000–39,999	98.7	98.8	97.0	94.1
40,000–49,999	99.1	99.2	98.5	97.8
50,000–59,999	99.4	99.5	98.7	97.5
60,000–74,999	99.5	99.6	98.3	98.9
75,000+	99.5	99.5	98.6	97.7
U.S. Total	93.3	94.6	83.5	82.7

Source: Alexander Belinfante, "Telephone Subscribership in the U.S.," Washington, DC: Federal Communications Commission (Industry Analysis Division, Common Carrier Bureau), February 1991, Table 4, p. 30.

of diffusion, "good" technologies will become nearly universal. In fact, that is not the case. To reap the full benefits of universal service will require more positive steps.

Public Technology, Public Choice

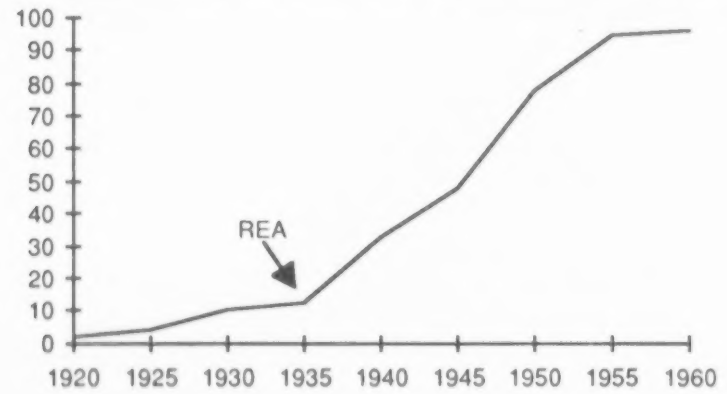
The first section showed that networked technologies exhibit features that are inconsistent with the assumptions of the diffusion of innovation model. In this section, I have expanded the critique of the model, showing that the idea of universal service as implemented in the United States entails three features—interactivity, widespread availability, and equity—that also do not conform to its underlying assumptions. The essence of that model is its reliance upon individual decisions to adopt or not adopt. Even taking into account the importance of social institutions in determining who will be early adopters and how they will interact with others in their communities to create a climate favorable to later adoption, the model still focuses on individual choice. But the decisions that have enabled us to achieve universal service even to the present extent were not solely individual decisions: The Supreme Court

mandated cross-subsidization, the Rural Electrification Administration provided low-interest loans for rural telephony, the states have created universal service funds to offset the high cost of connections and provide relay services for the deaf and other disabled users. In short, universal service is inherently public in nature: its interactivity creates social benefits that do not accrue to any particular individual user, these benefits are reduced if people do not participate, and the cost to poor or geographically isolated people would prevent their participation without some form of assistance; therefore, public assistance is merited. Its public nature means that governmental as well as individual decision making is required if universal service is to succeed.

In fact, government has long been an active participant in ensuring that technology is widely available for adoption. Figure 4, which illustrates the diffusion of electricity in rural areas, highlights this point by showing that the take-off occurred only after the Rural Electrification Administration (REA) began to offer low-cost loans for extending the grid.

Perhaps this example seems too obvious, involving a technology that, like the telephone, is networked and according to the argument of Section 1 does not fit the model. Consider instead a technology that should clearly fit the model of individual choice; namely, television.

Figure 4 Percent of Farm Households with Electricity



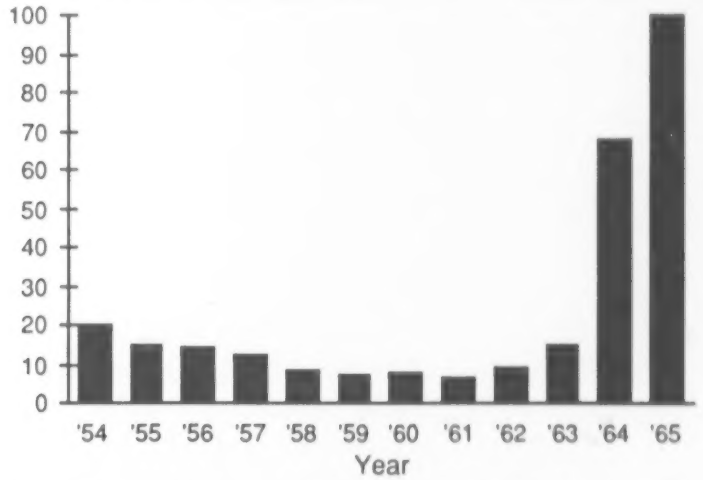
Source: U.S. Census, *Historical Statistics of the United States*, Part 2. Washington, DC: GPO, 1976. Table 108-119, p. 827.

Figure 5 shows that UHF television was actually declining in acceptance (reflecting broadcasters' reluctance to provide UHF signals) until 1963, when Congress amended the Communications Act to require all television sets to be capable of receiving UHF signals by 1965. The pattern for the number of UHF stations on the air is similar, of course, rising very rapidly from about 100 in 1965 to nearly 350 in 1974.[21]

However, the role of government in fostering technology is largely unacknowledged by the diffusion of innovation model. Our discussion so far suggests three appropriate and necessary roles for government in ensuring access to technologies that are part of universal service: setting standards, fostering equity, and ensuring rapid development of networked technologies.

Standard-setting has been a well-recognized role of government in fostering technology for at least half a century. The prescient Theodore Vail anticipated the need for standards, recognizing that the goal of universal service could only be reached if the system was standardized to allow interconnection and what we would now call "interoperability." Vail's vision of "One System, One Policy," could, in turn, only be

Figure 5 UHF Television Sets as Percent of All Monochrome Sets Sold

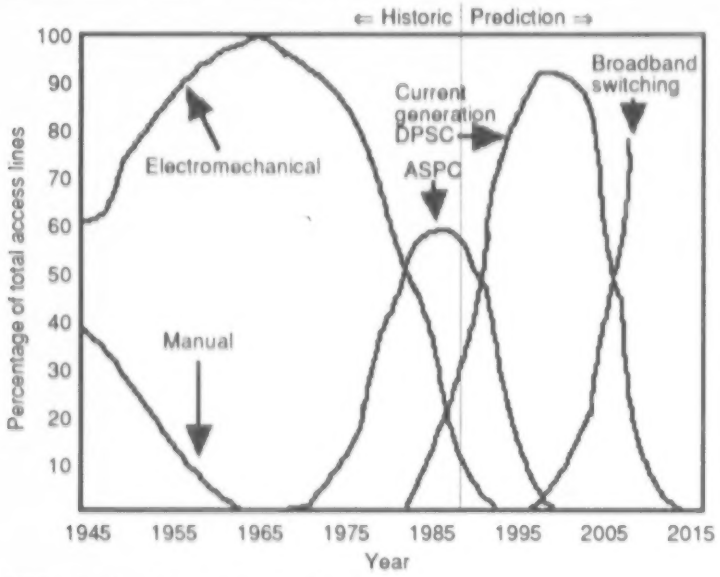


Source: Richard V. Ducey and Mark R. Fratrik. "Broadcasting Response to New Technologies." *Journal of Media Economics*, Fall 1989, p. 79.

achieved through monopoly control. One benefit of the centralized telephone system before divestiture was a continual upgrading of service in a relatively uniform manner. The historical portion of Figure 6 shows how smoothly new switching technologies were introduced and their predecessors phased out under the single Bell system. But in order to be allowed to have his monopoly, Vail and his successors had to accept governmental oversight, including control over rates and some policies.

It is still true today that universal service cannot be achieved in a system characterized by incompatible technologies. Without governmental oversight, businesses actually have some incentive not to make their services compatible, keeping captive those who have chosen their technology and trying to corner a majority of the market. AT&T and IBM successfully used this strategy in the past. Standards are especially important for achieving universal service in a highly competitive

Figure 6 Stages of Switching Technologies



ASPC= Analog stored program control
DSPC= Digital stored program control

Source: Lawrence K. Vanston, Ralph C. Lenz, and Richard S. Wolf, "How Fast is New Technology Coming?" *Telephony*, September 18, 1989, p. 49 (Figure 2).

deregulated market. Yet the rapidly changing nature of the technologies combined with the actors' strong motivations to ensure that their own products are adopted as the standard makes agreement on voluntary industry guidelines very difficult to achieve. Although standards may retard certain kinds of innovation, the costs of failing to set standards may actually be higher. In fact, the Federal Communications Commission's (FCC) call for information on which to base a standard for high-definition television (HDTV) arguably caused more rapid movement towards digitalization than would have occurred without government intervention.[22]

A second role for government concerns the equity aspects of universal service. Cross-subsidies, tolerated and even encouraged by regulatory agencies to ensure reasonable costs and therefore universality of service, are not likely in a multi-provider, competitive market. Instead the trend is toward unbundling of services and driving the price of each service toward its cost; this trend goes explicitly counter to a desire for universal service.[23] The more fragmented services are, the less likely each consumer will select the same bundle. Poorer consumers will be especially likely to select different bundles of services; if they are less able to interact with mainstream users, they will become even more isolated from the community. For example, in most states touch-tone telephones are still "optional" or subject to an additional charge. Those who cannot afford this service are unable to make use of the many services that now require digital dialing, including ticket purchase, on-line banking, and other cost-saving activities. Ironically, it is actually more expensive in most areas to serve those with the "basic" rotary-dial telephone. A collective decision to require touch-tone as basic universal service would lower the costs of the network as well as increasing social benefits. But such a decision cannot be taken without governmental intervention, since it is not in the individual interests of the relevant actors (phone company, individuals using rotary phones) to require a switch to touch-tone.

A final role for government arises from the inherently public nature of networked technologies. Large-scale communication and transportation networks capable of universal service, although owned privately, require the approval and beneficence of the public. Congress granted railroads and the telegraph rights-of-way; without this largesse, neither network would have grown. Today, network operators must disrupt

traffic and commerce while they dig up streets and lawns to upgrade their infrastructure; in short, they use public facilities and space. Thus they have a public character, which is only enhanced by the public stake in widespread access and affordable rates. Network operators must provide something in return for receiving benefits from the public; only government can ensure that the fragmented public receives its due from centralized providers.

In short, the way in which a networked interactive technology becomes woven into the very fabric of its society makes a universal service inherently public, and public goods are not provided in optimum quantities without a least some governmental action. This conclusion contrasts with the implicit assumption of the diffusion of innovation model that the sum of individual choices concerning adoption of technology properly determines which technologies succeed and which fail. The focus on individual choice is especially inappropriate in considering technologies for universal service, because its essential characteristics, including equity, widespread accessibility, and uniform quality of service, are unlikely to be obtained through uncoordinated individual decisions but instead require deliberate collective choice.

The diffusion of innovation model has other limitations for those hoping to assess universal service in the future. It is a descriptive model which cannot—and, again, was never intended to—clarify the normative choices implicit in the decision to make some service universal. It cannot predict nor clarify our understanding of the degree to which equity, whether geographic or economic, is achieved. It cannot tell us whether a cost is "reasonable" nor even whether a technology is available on a scale we are willing to consider "universal." Diffusion of innovation will also remain weak as a predictive model until explanations for the different slopes, the critical mass for interactive technologies, and the rate of diffusion for newly wired networks are subjected to further study. The theory must also be modified to take into account the fact that the cost of a wired service depends on a variety of factors not controllable by the manufacturer, including distance, ability to obtain rights-of-way, and the cost of retrofitting the receiving building.

Thus we see that in assessing telecommunications needs there is a striking contrast between analysis based on a market or individual choice approach and analysis that recognizes the inherently public nature of universal service. The next section suggests that the growing

availability of advanced technologies that could provide much more sophisticated universal service heightens this contrast rather than alleviating it.

SECTION 3
UNIVERSAL SERVICE BASED ON ADVANCED TECHNOLOGIES

Although the decision about universality (or the lack thereof) is a policy or vision, the availability or near-availability of a range of new communications technologies has served to pique people's interests in redefining that vision. Many authors have provided us with excellent overviews of the trends in new communications technology.[24]

Trends Most Important for Universal Service

Computerization. As more and more communications technologies rely upon computers, they become both more powerful and easier to use, two features that enhance their potential universal adoption and use. Among the trends affecting computers are:

- Increased processing speed (often associated with decreased size). This trend itself results from two different kinds of technological advances: 1) advances in technology which allow increased speed within the computer itself, including new materials, new chip design, the possibility of replacing electrical with optical components, and new input/output designs; and 2) a range of developments that allows faster transmission among computers. This is especially important, since within-computer speed has long been much higher than among-computer speed. New network architectures and means of communicating among computers are gaining in importance because the computers will be "parallel processors" that are composed of more than one central processing unit (CPU).

- Increased capacity. Increased speed of processing allows more information to be processed. Users of personal computers are familiar with the rapid expansion in both long-term and short-term storage: Hard drives are available in near-gigabyte sizes while random access memory (RAM)[25] has increased by nearly three

orders of magnitude in approximately half a decade. Optical storage is extremely efficient; A 5¼-inch disk holds 500 kilobytes of information in magnetic form, but 600 *mega*bytes in optical form. In June 1991, the Microelectronics and Computer Technology Corporation, a computer industry consortium based in Austin, Texas, announced development of a holographic computer memory that transcends the need to store and retrieve data one bit at a time, vastly increasing both capacity and speed.[26]

- Increased software sophistication. Software and hardware have a dynamic interactive relationship, each pushing the other to higher speeds and performance. One important area of software development is data compression, which allows large quantities of data to be sent more efficiently. This development is of special importance for a wide range of communication needs, enhancing transmission of video data, facsimile, and so on and allowing spectrum to be put to previously unthought-of uses. Advances in expert systems and data base software will affect the ease with which people can retrieve information and the efficacy of its storage. Advances in switching software and the increased use of virtual switches add both speed and flexibility to the network. Advances in encryption and decoding have already made possible an increased density of cellular telephone service; further advances will be central to concerns of privacy in the operation of any nationwide network. Finally, advances in voice recognition, natural language understanding, and related "interface" software will increase the accessibility of complex technologies to lay users.

End-to-end Connectivity (Systems Integration). Because all telecommunications media increasingly use computers, information in all forms—audio, video, data—is increasingly digitalized. This common element allows the now divergent systems for carrying these different signals to become more unified. This change in the nature of transmission is complemented by the change in switching; formerly manual, switches became electromechanical and are now digital. Networks based on digital switching use software to achieve a high degree of self-management such as call routing, toll calculations, and trouble shooting. The network itself generates signaling information as a part of its

management operations. It is this level of network sophistication that allows for caller identification and other enhanced services. These advances in transmission and switching gave rise to a model for system unification called the integrated services digital network (ISDN) in which the "intelligent network" converts and reconverts signals as appropriate. Similarly, the recent decision by the FCC to support open network architecture (ONA) is intended to allow diversification by allowing a wide range of information appliances to connect to the network. Broadband ISDN (B-ISDN) is a related concept but offers the ability to transmit more information-intensive services such as video in both directions.

Convergence of Technologies and Increase in "Multi-media" Services. The digitalization of audio and video signals not only allows the various kinds of signals to be transmitted on a single network but contributes to the blurring of distinctions among the different media. I receive a newspaper that is transmitted to the printing press by satellite and a television program that has never been outside a wire. Cellular telephones use spectrum rather than wire to deliver voice communications. Fax machines use wires to deliver print. High-definition television will almost surely be delivered as digital signals, either through wires or over the air. And now traveling executives can receive faxes, voice mail, and electronic mail in one single telephone call, ironically deploying a very old communications technology to reintegrate the new ones.[27]

This convergence of technologies has led to the growth of "multi-media" services. Stereo television sets allow users to receive an audio band unrelated to the program they are watching, as if the radio were turned on as well.[28] High-end personal computers can take input from video cameras, videotape players, and laserdisk players (as well as from scanners and other pedestrian sources of images) and allow users to edit, store, and disseminate the resulting "movies." Possible audio inputs are similarly diverse. The computer can also be hooked up to CD players, VCRs, and other standard display devices, switching on one or more at the command of the user or of a computer program. Although digitalization is the *sine qua non* of multi-media, data and image compression are equally important, especially in making multi-media available to home users. Project Athena at the Massachusetts Institute of Technology offers a language teaching program that allows the student to "walk

through" a foreign city on screen, stopping to converse with people he encounters. The conversations are also displayed in text to assist understanding; if the authors had chosen, they could also have made a translation available at the same time. Instead, students may select words that puzzle them and obtain dictionary definitions, all without losing sight of the place in the city where they have "stopped" to talk.

Decreased Size and Cost. The decreasing size of electronic components and their decreasing cost are generally expected to continue for some time, especially as new optical technologies are commercialized. Portability, spurred by miniaturization, is enhanced by advances in cellular technologies that limit the need for wires to deliver audio and data signals. Decreasing cost has two conflicting results: on the one hand, it makes the new technologies increasingly accessible and, on the other hand, it also makes more possible the proliferation of private networks and other forms of exclusive systems as the costs of paying for an entire system become feasible for single large users.

These trends pave the way for much more complex forms of universal service. Interactivity, once the exclusive province of the switched telephone network, could be available for and through many other media as well. It is particularly noteworthy that we now have a switched spectrum-based network for cellular telephones, and that a full-fledged switched network covering long as well as short distances by radio wave is likely in the foreseeable future.[29] The almost limitless capacity of fiber optic cable has spurred visions of interactive full motion video through fiber to the home.

However, one important characteristic of the interactivity fostered by the new services is that there is usually much more information flowing one way than the other. For example, few people will expect to send out modified video pictures; instead, they will expect to be able to select certain video-based services they want to receive. Most of the information coming from homes will remain voice or will comprise text messages (for bulletin boards or electronic mail, for example). Thus even services that require considerable bandwidth on the incoming side may not require so much on the outgoing side. Combined with compression technologies that allow for an acceptable level of service at bit rates that are achievable now, it may be possible to provide interactive services without fiber all the way to the home.[30]

Reasonable cost, another central feature of any universal service, is the direct outcome of the increasing computerization and digitalization of telecommunications. Indeed, it is the prospect of providing hitherto inaccessible technologies at anything like an affordable cost that has elicited new interest in universal service at all. Fiber to the curb, signal-splitting technologies, and the increased bandwidth capacity of copper over very short distances constitute a relatively low-cost means of delivering relatively high-quality interactive services. The cost of fiber itself is dropping rapidly.

Widespread availability and use, the final characteristics of a universal service, are also fostered by these technological developments. More powerful computers allow for increased ease of use and flexibility, encouraging even the technologically unsophisticated to adopt the new services rapidly. End-to-end connectivity enables a uniform quality of service to be available, while the convergence of the technologies allows even the most difficult of geographical barriers to be transcended.

In short, a virtually infinite set of possible services could be made "universal" once an integrated and perhaps broadband network is available. However, it is possible to identify a few paradigms that exploit the most important of these trends. The following discussion focuses on four, which I have called the personal telephone, essential information, the unintelligent network, and targeted services.

The Personal Telephone

One form of universal service might be a telephone number attached to an individual rather than to a place. The important elements of this form of universal service are its complete universality (everyone would have a telephone and a number), its portability, and its likely reliance on spectrum as the primary transmission medium, with the wired network serving as backup or to provide bandwidth-intensive services. One version of this universal service might look as follows:

> *Upon reaching a certain age, perhaps 12, each person is assigned a telephone number and given a pocket receiver, similar to a cellular telephone, that also contains a screen sufficient to display 100 characters. The telephone can also be connected to a computer or other customer premises equipment (CPE). In*

fact, its most common configuration would be plugged in, because this would allow the phone owner to receive data and, depending upon the CPE, video signals as well. However, it could also be carried around in automobiles, to the beach, etc.

A person wishing not to receive calls could turn off the phone. Next time he turned the phone on, the display would show that messages were waiting. He could receive them via voice mail. Users could also forward calls to a different telephone number. This would be standard practice for some employees during working hours, since aides could screen calls just as they do now. (Thus some telephones would remain attached to a location, rather than to a person. These phones would not be part of universal service, but subject to a surcharge.) The display could also receive brief non-audio messages, such as a confirmation number, and send similar messages, allowing users, for example, to conduct banking activities from anywhere.

The telephone, related telephone service, voice mail, and call forwarding would be a single service package. Although the telephone would be a sophisticated appliance, theft would be discouraged by the fact that each phone would be limited to its particular number, associated with an individual. Although the phone would be most effective plugged into more sophisticated CPE, by itself it would serve the essential purpose of linking every individual to the network.[31] People as marginal as the homeless could still be contacted or call to obtain work and everyone could easily be contacted in case of a personal or civil emergency. Voice mail or another form of delayed messaging is central to the nature of this service, because people who are more marginal—less closely associated to a range of institutions—are more difficult to contact generally and more likely not to have access to other forms of message storage. The social benefits of such easy contact more than balance the small additional costs of including delayed messaging in the smart network.

Essential Information

The form of universal service I have called "essential information" focuses on a function, rather than a particular technology. However, it

is logically related to the possibility that broadband (or broader-band than at present) services will be available in people's homes. Thus it expands on the idea of the wired network, the convergence of technologies, and the notion of ISDN. Its premise is that adequate functioning in an "information society" will require access to at least some kinds of information, and that these should be readily available to all at low or no cost. As I have argued elsewhere,[32] this is not a novel form of universal service. State laws requiring a free public education, public libraries, labeling requirements ensuring that consumers can obtain information necessary to a reasoned purchase, and both worker and community right-to-know are all precedents that have ensured people access to free information. It is worth noting that these precedents uniformly entail providing information that benefits society as a whole that individuals either have little incentive to obtain or simply cannot obtain unassisted. One form of this kind of universal service could be as follows:

> *Homes, schools, and libraries would obtain an InfoTel©, either for a modest fee or as a built-in appliance. Containing a television screen, an alphanumeric keypad, speakers, and a TV-like remote control, this appliance serves as a gateway into a wide range of information services, some of which are automatically charged to the location and some of which are included as basic service. The appliance allows interactive use of audio, video, and data signals and provides for simultaneous receipt of audio and one of the other kinds of signal. This permits, for example, on-line tutoring or assistance in completing government forms. The InfoTel can be programmed to select certain information and provide it automatically upon a simple voice command. InfoTel can provide voicing of information usually offered as on-screen print for use by the visually handicapped and those who cannot read, and can provide voice messages in written form for the hard-of-hearing or for purposes of maintaining records.*
>
> *Publicly-sponsored information services include posting of homework along with assistance to parents helping children with homework, calendars of public events, access to public meetings and hearings, basic local and national news, contacts in government agencies, access to certain government services*

(on-line property tax appeals are already under consideration in some jurisdictions), access to on-line encyclopedias and other reference works, disease prevention and public health information, and adult literacy tutoring. Privately-sponsored free services might include regional "yellow pages," price lists for products in local stores, and on-line banking. Service providers would be responsible for updating information, which they could do through a special access code allowing them entry into only their portion of the information base. Service providers could also give customers special access codes to obtain information about price specials or for other services. Other information services that would carry a price tag might include stock quotations, news services, specialized information for research, on-line professional journals, on-line newsmagazines, movies, and a host of other possibilities.

Although the InfoTel would be very easy to use, obtaining information efficiently from public and private data bases is a skill that needs perfecting. Schools would have numerous of these connections to the outside world, and starting from a very young age, students would use them to complete assigned tasks. Learning how to obtain tutoring and homework assistance would be one of the very earliest skills; gradually students would refine skills in finding, selecting, and even assessing information. Just as today children are often the agents bringing parents into the computer age, the children's matter-of-fact use of the new appliance would reassure and teach their elders the value of the new tool.

Again, the justification for providing so much information at low or no cost is the social benefits accrued. For example, we presently spend $670 billion on health care. If the preventive information and ability to communicate easily with a health care provider saved as little as one percent of this, it could go a long way toward funding the provision of the information itself.[33] This is particularly true considering that once a broadband network is installed and the information accumulated in usable form, the cost of delivering any particular increment is extremely small. If the information is already paid for, as would be true for information collected by government agencies in the course of fulfilling

their normal duties, there is little reason to charge taxpayers again. Any time that universal service offers a cheaper way to deliver already-mandated services, it is also merited.

The Unintelligent Network

One important "technological" question is how much intelligence will be in the network compared to the amount of intelligence in the CPE. While the universal service described above relied heavily on an intelligent network, the following scenario emphasizes open network architecture, which, Solomon argues, will have the effect of pushing intelligence out of the network and into the CPE.[34] A similar effect is likely from the advent of B-ISDN and from the unbundling even of services available now, such as call forwarding and call waiting. The present trend is certainly toward opening the local telephone loop to competitors,[35] thereby forcing the local telephone companies to unbundle many services described as universal in the preceding scenario. This kind of universal service might look like this to two different users:

> *Lee Smith owns a small credit management and collection agency. He employs 15 people who oversee accounts, approve credit, and work with creditors on repayment schedules. Because he serves as the credit department for tens of small businesses, he must keep in constant contact with each of them as well as with the thousands of creditors. With the advent of the new era in telecommunications, he hopes to reduce his telephone, fax, and other communications costs. Smith places calls to three service providers whose ads he has seen recently. Each spends a couple of hours with him, touting the advantages of his own package. No package is identical to any of the others, and the rate structures are sometimes based on time of day and sometimes on intensity of use. Smith cannot evaluate all this information nor relate it to his needs, so he has his accountant put together a spreadsheet of present telecommunications costs and takes it to an information service repackager who attempts to find him the best deal. He advises Smith to purchase a mid-range InfoMediator, which will allow his existing networked microcomputers to send faxes and voice*

mail automatically to delinquent accounts. Smith is pleased to find that his communication costs have decreased noticeably, but his interest payments on the capital investment in the InfoMediator represent a new cost; his one-time payment to the repackager was also substantial. Moreover, it takes his computer person more than three months to fine tune the interface between the network protocol and the InfoMediator protocol, during which he has received numerous complaints about dunning at wrong numbers and having incorrect accounts. A year later, Smith acquires a new account and is unhappy to discover that his InfoMediator cannot be upgraded to cope with the new demands.

Down the street, at a branch of a major stock brokerage, a team from the home office has come in and taken up residence for two weeks. Evaluating the level of business and its distribution among several time zones (including Japan's), the team has determined which of the different versions of the company's own AssetAdvisor hardware is most cost-effective. After installing the software, the team conducts training for all employees, tailored to the specific tasks that they will be completing while encouraging lower-level employees to learn functions of higher-level employees to provide for future advancement. Communications costs, a significant component of the budget, drop steadily over the next three years.

When AT&T was broken up, consumers found themselves at a great disadvantage in selecting long distance carriers. They were subjected to misleading advertising[36] and, more often, to rate schedules that were very difficult to interpret and almost impossible to compare. The conversion fee for switching providers, although low, is a barrier for many people, causing them to stick to their initial choice even if it is not cost-efficient.[37] In short, the costs of acquiring, understanding, and acting upon information about competing telecommunications services are very high and the certainty is very low. Unbundling and placing of intelligence in the CPE allows in theory for careful tailoring of a service package to a users' needs; in practice, it hurts small consumers and probably results in considerable social inefficiency in use of resources. This problem is exacerbated if there are no disclosure requirements,

allowing potential service providers to make claims that cannot be evaluated except by the most expert consumers.

Targeted Services

One of the most important results of the technological changes reviewed above is the increased ability to target services to particular audiences and, at the same time, for individuals to tailor the services they receive to fit their special interests. Important technological features implicit in such services are software that can "learn" the user's preferences and the ability to provide most services asynchronously.

> *Roger, tired from the day's activities, comes home and tells his AnswerAll to deliver his messages, show him the most important headlines, and tune into some amusing sports event. Later he asks for more detailed news. The AnswerAll reminds Roger of tomorrow's activities and gives a quick summary of how his stocks have performed.*
>
> *The following morning, Roger and Mary meet for coffee. "Hi," says Mary. "Wasn't that shocking about the mayor?" "What about the mayor?" replies the bewildered Roger. "Didn't you watch the news last night?" asks Mary. "The mayor walked out of his office and shot a man on main street in broad daylight." "Oh," says Roger. "My machine knows that I hate stuff about violence, so it probably just suppressed that headline. I wonder how I can program it to override the 'no violence' rule for really important events."*

Along with other boons of technology come some difficulties. Smart software is probably not smart enough to capture all the possible refinements in a person's interests, causing him to lose some information of interest. Much more important is the possibility that such targeted services will actually divide the community rather than integrating it as a universal service should; Roger thought he was receiving "the evening news" and so did Mary, but they didn't see the same show and one element of commonality was lost. The increased ability to deliver such targeted services also tempts providers to obtain more and more information about individuals with likely unpleasant consequences for their privacy.

Thus we come full circle, finding that technology stimulates us to visions that are likely to be realized only through tough policy choices. Assuming that the market can achieve these visions unaided is wrong, just as using the diffusion of innovation model to predict how new technologies will fare is a trap. Circumstances are now so different that extrapolating from the past cannot provide insights into the future. The predictive portion of Figure 6, for example, assumes that substitutions in switching technologies will occur in the same smooth way they did when almost the entire system was controlled by a single company; as the number of entrants into the market increases, the likelihood of a such a smooth substitution decreases.

It is a cliche that we can master or be mastered by technology, but it is nonetheless true. The new communications technologies clearly have the potential to provide forms of expanded universal service that will meet many of our national goals, including increased competitiveness with Japan (which has itself adopted an expansive vision of universal service) and economic recovery. These same technologies have the potential to reinforce existing social problems. Which effect they have is not a function of the technologies themselves, but of our own decisions to deploy them.

CONCLUSION

Universal service is, as its name suggests, not a technology to be adopted at the whim of individuals, but a social vision to be achieved through collective action. The term implies many values. Among these (overlapping) dimensions of universal service are equity, interoperability, interactivity, reasonable cost, widespread availability, and high and uniform quality. From the time of Theodore Vail, the idea of universal service represented the insight that social benefits would be maximized by a single, affordable, omnipresent telephone network. The primary provider, prodded in part by its public overseers, gradually decreased rates and increased the quality of service.

Although technology alone cannot ensure that the values embodied in the idea of universal service are achieved, new developments in telecommunications technology do hold the promise of an expanded vision of universal service. In-home job searching, desktop publishing, low-cost monitoring of home-bound chronically ill people, and

telecommuting are but a few of the exciting possibilities that could be implemented as early as the beginning of the 21st century. Yet the social context which originally fostered the universality of telephone service has vanished, perhaps never to return. It might require the public or the Justice Department to allow a bargain to be struck under which a latter-day Vail would promise fiber to the home and a personal portable telephone by 2010 in return for a monopoly. Even under the strictest standards of modern benefit/cost accounting, however, it is clear that net social gains will be highest if a relatively high level of interactive telecommunication is available to every member of society.

The appropriate solution must be to develop, publicly, both goals and the parameters within which to achieve those goals. Yet today's debate seems to be couched largely in terms of the past: whether regulatory barriers should be lowered, whether certain actions require anti-trust oversight, and how individuals adopted innovative technologies. The largely descriptive nature of the diffusion of innovation model reinforces this backward-looking tendency while its focus on individual behavior reinforces the present tendency to rely exclusively upon the market to achieve social purposes. Indeed, the diffusion of innovation model is a model for and about our market-oriented times. Reliance on this model tempts us to consider future forms of universal service by asking only what technologies or services individuals will readily adopt. This very question has implicitly or explicitly been asked, and the answer has uniformly been entertainment. Recognizing that universal service is a social vision to be achieved collectively turns us away from this wrongly-phrased question toward a better one; namely, What services do we want to have universally available?

Nevertheless, there is much to be learned from a judicious examination of the historical data. For example, government policy has often served in the past to stimulate a take-off in adoption of innovations. Low-interest loans for capital investment in wired infrastructure, mandates that a particular level of service be available, and support for research and development are proven methods of public intervention to achieve higher penetration of certain technologies. Although I have identified a relatively gradual rate of diffusion for wired infrastructure while others who focused on interactive technologies believe that the curve for these will be very steep, it is significant that the inference from both of these observations is the same: To achieve rapid and thorough

diffusion of desirable technologies fitting these descriptions, some public/governmental action will be required.

Another insight about universal service to be gained by reference to the past concerns the relationship between the wired network and innovative technologies. The wired telephone network did not deliver separable services; it was the essence of the service itself. Electricity, conversely, became an infrastructure the availability of which allowed individuals to make use of new technologies as they appeared: electric irons, refrigerators, radio, and the thousands of gadgets we take for granted today. The new telecommunication network will be in many ways a combination of the two, both enabling and delivering a range of services. Moreover, the new network has the capability of subsuming very different amounts of service in the form of "intelligence." Thus choices about the nature of the network will have a more profound and immediate effect on the level of services that will be regarded as universal than was the case heretofore. The very size of this effect again suggests that the choice is more appropriately public than private.

Finally, an examination of the past—not of data on diffusion, but of ideas and values—shows that there is an important relationship between universality and essentiality. We no longer expect people to "make it" without elementary education, adequate nutrition, electricity, or the telephone. The new telecommunications services, which will provide access to livelihood, education, and the community as well as easier business transactions, are rapidly becoming equally essential. However, the reasonable cost and standard quality components of any universal service have seldom flowed from pure application of market forces. Instead, they have required purposeful pursuit of a social vision.

Expanded universal service is not merely a vision, however. It is an economic necessity: a means for maintaining a position as a global power, stimulating small business, and pulling economically and geographically marginal citizens back into the mainstream. Public policy is always an appropriate tool when everyone gains; in the case of expanded universal service, the effect of a forceful policy will be to expand the size of the entire pie, giving a bigger piece to everyone.

Although some of the newest technologies may not be fully commercialized, the window of opportunity for ensuring that they are part of an expanded universal service is very narrow and it is closing rapidly. Increasing privatization, documented by Eli Noam in another paper in

this volume, slow promulgation of standards, and rapid deregulation decrease the likelihood that we will be able to expand universal service. Taken together, these trends represent a real and immediate threat to a form of universal service that is crucial both to our democracy and to our economy.

Now is the moment to choose. The choice must be made collectively, however, and it should be made with the long rather than the short term in mind. We must expand universal service, however gradually, to ensure that everyone is a full participant in the benefits of new telecommunications technologies. The goals of the 1934 Communications Act—interactivity, widespread availability, and equity—are still valid today, but they are threatened by the retreat from collective decision making. It is only when microprocessors and RAM, decoders and smart telephones, fibers and lasers, have become technologies of universal service that they may truly be said to be "technologies of freedom."

Edward Lenert, Ph.D. student in the College of Communications, provided valuable assistance in the preparation of this manuscript and in refining presentation of its ideas. Its errors are, of course, not his.

ENDNOTES

1. Rogers, Everett, *Diffusion of Innovations* (Third Ed.). New York: The Free Press, 1983.
2. Carey, John, and Mitchell L. Moss, "The Diffusion of New Telecommunication Technologies," *Telecommunications Policy*, June 1985, pp. 145–158. A similar point is made in Walter S. Baer, "New Communications Technologies and Services," in Paula R. Newberg, ed., *New Directions in Telecommunications Policy*. Durham, NC: Duke University Press, 1989, pp. 139–169.
3. Considering the massive investment made by RCA to allow television to be adopted by almost everyone within five years, Ithiel de Sola Pool, in *Forecasting the Telephone: A Retrospective Technology Assessment of the Telephone*, Norwood, NJ: Ablex, 1983, wrote: "If the phone system had had to be introduced in that way there would have been a delay of decades. The problem the phone promoters faced in the 1870s was to find potential users of the new device who would get value from it, even when linked to only one or a few other sets. Businesses or professional people who had to maintain regular communication among limited operating points were thus the natural clients. Starting with initial subscribers to such 'intercoms,' the phone system could grow gradually and incrementally. The economics thus favored a point-to-point phone system, not a telephonic mass medium" (p. 82).

4. This helpful phrase is used by Mitchell Kapor in "Civil Liberties in Cyberspace," *Scientific American*, September 1991, p. 160, col. 3. Ironically, Kapor is arguing that a multiplicity of nodes on the network would not command the shared resource in the same way as the broadcast network. Although I disagree with Kapor, since the burden of my argument is that networks are shared resources, the phrase still reflects exactly the point I wish to make.
5. There are a number of caveats on the basic supposition that diffusion rates differ according to the infrastructural character of the technology. First, the supposition is difficult to test fully because there are so few technologies involving newly-built infrastructure (electricity, telephone, and cable) compared to the relatively large number of "post-infrastructure" technologies. Another factor that might confound any attempt to extrapolate from the past to the future is that the general pace of adoption has increased as people have become more familiar with the whole idea of changing technology. This would mean that electricity and the telephone, the earliest of the technologies included in this analysis, would show a slower adoption rate in part because their invention and early commercialization occurred in the 19th century. Cable, a wired technology, differs from these earlier two in that it is not a novel technology, but an alternative method of delivering a familiar technology. This difference is doubtless significant enough to ensure that cable will not be adopted according to the earlier "wired" pattern.
6. See, for example, Jurgen Schmandt, Frederick Williams, Robert H. Wilson, and Sharon Strover, *Telecommunications and Rural Development: A Study of Business and Public Service Applications*. Austin, TX: LBJ School of Public Affairs and the College of Communication, December 1990; others. Also Pool, *Forecasting the Telephone*.
7. *Recent Social Trends*, p. 431.
8. Quoted in Pool, *Forecasting the Telephone*, p. 21.
9. Ibid, pp. 22, 24.
10. Ibid, p. 28.
11. Ibid, p. 52.
12. M. Lynne Markus, "Toward a 'Critical Mass' Theory of Interactive Media: Universal Access, Interdependence, and Diffusion," *Communications Research 14* (October 1987), pp. 491–511.
13. Williams, Frederick, Ronald E. Rice, and Everett M. Rogers, *Research Methods and the New Media*. New York: The Free Press, 1988, p. 74. The authors draw on Markus's work and extend it.
14. Calculated from figures provided in Andrew F. Inglis, *Behind the Tube: A History of Broadcasting Technology and Business*. Stoneham, MA: Butterworth Publishers, 1990, p. 384.
15. First introduced in Springfield, Massachusetts, in 1883, pay telephones constituted 3.5 percent of all telephones by 1902. Pool, *Forecasting the Telephone*, p. 22.
16. *Butte Community Union v. Lewis*, 745 P.2d 1128 (Mont. 1987).
17. Colton, Roger, "An Evaluation of Low-Income Utility Protection in Maine: Winter Requests for Disconnect Permission," Volume 1, Boston: National Consumer Law Center, July 1988, pp. 16–19.
18. President's Research Committee on Social Trends, *Recent Social Trends in the United States*. New York: McGraw-Hill, 1933, p. 199.

19. Quoted in Ida Walters, "Freedom for Communications," in Robert W. Poole, Jr., *Instead of Regulation: Alternatives to Federal Regulatory Agencies*. Lexington, MA: Lexington Books, 1982, p. 119.
20. *Smith v. Illinois*, Bell Telephone Company, 282 U.S. 133 (1930).
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22. For television standards, see Inglis, *Behind the Tube*. For HDTV, see Corey P. Carbonara, "A Management Overview of High Definition Television," 1990. For AM Stereo, where the FCC allowed the marketplace to determine the standard, see Bruce C. Klopfenstein and David Sedman, "Technical Standards and the Marketplace: The Case of AM Stereo," *Journal of Broadcasting and Electronic Media 34* (Spring 1990), pp. 171–194. The authors note that in a regulated area such as radio broadcasting, it is especially inhibitory of innovation to avoid setting standards, although this can also prevent market adoption of such innovations as quadrophonic sound. Finally, for a review of all the advantages of setting standards to accelerate diffusion, see B. Rosen, S. Schnaars, and D. Shani, "A Comparison of Approaches for Setting Standards for Technological Products," *Journal of Product Innovation Management 5* (1988), pp. 129–139.
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24. See, for example, Baer, "New Communications Technologies and Services"; Richard Jay Solomon, "Shifting the Locus of Control: Computers and Communications in the 1990s," *Annual Review of Communications and Society, 1989*. Nashville, TN, and Queenstown, MD: Institute for Information Studies, 1989, pp. 1–44; and Frederick Williams, *The Intelligent Network: Social and Economic Options for the Information Age*. New York: The Free Press, 1991. Other useful references include Robert A. Meyers, ed., *Encyclopedia of Telecommunications*. San Deigo: Academic Press, 1989; and Micheal M. Mirobio and Barbara L. Morgenstern, *The New Communications Technologies*. Boston: Focal Press, 1990.
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UNIVERSAL SERVICE AND NREN

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> The regulation of electronic communication is not entailed in its technology but is a reaction to it. Computers, telephones, radio and satellite are technologies of freedom, as much as was the printing press.[1]

In the hearing rooms of Congress, the boardrooms of high tech industries, and the computer centers of major universities there is a highly technical debate taking place about gigabits, backbones, and interconnectivity. The outcome of this debate, largely ignored by the popular media because of its technical nature, will shape the fabric of American life in the 21st century. The undercurrent of the debate is not about technology type or capacity. It is about a fundamental principle of our democracy, a citizen's freedom. The consequence of Congress's action on this issue may determine who will have access to information and who will not, and whether or not all of our children will have access to a quality education.[2]

Futurist Alvin Toffler says that the very survival of the U.S. democratic form of government depends on building interconnected high-speed electronic networks that will form the key infrastructure of the 21st century. He likens these networks to the railroads and highways of an earlier era.[3] The debate going on in Congress is about one of these networks, one designed to meet the information needs of the education

community. The National Research and Education Network, or NREN, is the information superhighway proposed by Senator Albert Gore Jr. (D-TN), designed to meet education's research, communications, and instructional needs.

WHAT IS NREN?

NREN (pronounced "en-ren") is a proposal contained in the High Performance Computing Act of 1991 (S.272) authored by Senator Gore, Chairman of the Senate Subcommittee on Science, Technology and Space. First proposed in 1988, NREN would be a federally funded telecommunication infrastructure that would expand, upgrade, and interconnect the existing array of mostly scientific research networks, such as the National Science Foundation's NSFNET, and regional networks such as New York's NYSERNET, which are known as the Internet. The goal of NREN is:

> to enhance national competitiveness and productivity through a high speed, high quality telecommunications network infrastructure which would support a broad set of applications and network services for the research and instructional community.[4]

The original purpose for NREN, as it was introduced in 1988, was to create an interconnection between the nation's research universities and super computer centers which were largely supported by the National Science Foundation and the U.S. Department of Energy. The network was conceived as a means of shared use and shared cost to accommodate the massive amounts of data produced by high-performance computer projects. Beyond the initial use proposed, such a broadband digital network could also accommodate many other sorts of applications.

It did not take long for the nation's librarians and educators to see many other research and instructional applications that a high-speed universal electronic network could support. What began as a National Research Network expanded, and the proposal was changed to the National Research and Education Network.

Initially, the reason for the expansion was to create a larger constituency to support the substantial expenditure of federal funds to

construct and subsidize use of what is essentially a private network for education, built initially with federal funds.

Gore's original bill called for $650 million to be allocated to the National Science Foundation and another $338 million for NASA to research and construct NREN. The current version includes authorization for five fiscal years averaging about $200 million each year.

The White House, despite current recession woes and economic pressures brought on by the Persian Gulf War, is also promoting similar plans for multi-million-dollar investments in super computer research and development. President Bush has recommended that Congress allocate $149 million to NREN in this year's budget.

Much smaller amounts of federal money have been proposed for NREN in previous years, and proponents of the network hope that the administration's new and expanded level of support will provide the momentum to get a significant allocation for NREN in the Congressional budget this year.[5] Gore's bill passed out of the Senate this summer and is currently under consideration in the House.

The current NREN bill is made up of seven titles:

- Title I designates various agencies to work out a five-year plan for national super computing. Agencies included are: the Department of Energy, NASA, the National Institute of Standards and Technology, and the Defense Advanced Research Projects Agency.

- Title II charges the National Science Foundation (NSF) to work with other organizations such as super computer centers and research universities to establish NREN.

- Title III charges the NSF with ensuring that federally funded data bases and network services can be accessed via NREN. The services would include directories of users, digital libraries of electronic books and journals, software libraries, and research facilities. This section of the bill has been touted by supporters as a "universal service" for access to the enormous knowledge base available throughout the current connected system of academic networks. In addition, access to commercial services such as Compuserve, Prodigy, and InfoNet would be provided over the network, something that is done in a very limited manner on the current Internet.

- Title IV calls for the development of software to meet "grand challenge" problems in science and engineering, and for clearinghouses for research software.

- Title V encourages development of new supercomputing technology by the private sector.

- Title VI promotes basic research in computer technology and for education of computer scientists, scientists, certain engineers, and library information scientists.

- Title VII includes the authorization of federal funds for fiscal years 1992 to 1995 averaging about $200 million each year, a modest sum compared to the annual federal research and development budget in science of $70 billion.[6]

People and organizations testifying in support of the Gore bill this session have included John Rollwagen, the chairman and CEO of Cray Research; the director of the National Science Foundation; the chancellor of Vanderbilt University; the Librarian of Congress; Robert Kahn, president of the Corporation for National Research Initiatives; and leading corporate executives from Xerox, Auto Desk, IBM, Apple, and MCI.

WHY IS THERE SUCH EXCITEMENT ABOUT NREN?

The original supporters of NREN saw its proposed research support interconnectivity as a way to maintain the international competitiveness of the United States. As Rollwagen said in testimony before Gore's committee in support of NREN: "It is clear that the super computer highway will quickly catapult U.S.-based researchers into new levels of productivity and creativity by providing not only more accessibility but also more timely results. . . . This will provide for greater rates of innovation—the only true offensive weapon in our economic race for global industrial leadership and continued national security."[7] Rollwagen and other witnesses pointed to massive, governmentally supported networks being built or planned in countries such as France, Germany, and Japan. Gore described the NREN as "an investment in our national

security and our economic security. It would create a laboratory without walls by allowing massive information exchanges quickly." All proponents argued that the United States is facing a serious challenge to its leadership both economically and technologically because of our lack of coherent policy on deploying a universally available broadband electronic network.

Unfortunately, since the divestiture of the AT&T Bell system almost a decade ago, our policy focus on a competitive marketplace in telecommunications has not led to national planning of a universally accessible broadband network. The historic consensus behind telecommunications policy in the United States, which led to the Communications Act of 1934 and its visionary universal phone service, has been fractured and lost. It has been replaced by a highly competitive environment in which special interests and private networks dominate. NREN as it is would be another of these special interest private networks. The key difference is that it would be financed with taxpayer dollars.

In 1987, MCI and IBM were awarded a contract to expand the backbone of NSFNET and INTERNET, while the seven regional Bell operating companies were precluded from participating in the expansion because of Judge Harold Greene's Modified Final Judgment (MFJ) based on the Bell companies anti-trust settlement. The seven regional phone companies are charged with maintaining universal service, at low cost, to the voice grade phone network in this country, but they were precluded from competing for expansion of the high-speed data network.

Certainly the seven Bell companies, and many other scholars concerned with information service development in this country, argue that the companies should be allowed to expand the backbone of the public switched phone network to make it the universal access point to a broadband voice, data and video gateway.[8] If this were to happen, there would be much less need for and support of Gore's proposed expenditure of $1 billion for the development and deployment of NREN.

So far, Congress and the Federal Communications Commission (FCC) have not been able to resolve these issues. However, on July 25 of this year, Judge Greene lifted the information services restrictions imposed on the Bell companies by the anti-trust settlement. Despite the fact that appeals to the judge's decision may take some time, it is fairly certain that the seven regional Bell companies will begin upgrading the

voice grade phone network to a broadband digital network. This development may change the focus of the NREN debate to a broader discussion of private expansion of the current phone network into broadband services to the home.

The virtual standstill of telecommunication policy at the federal level on issues pertaining to the deployment of a central broadband network to serve public sector needs has produced excitement about NREN because it seems to be based on the belief that, for now, it is the only game in town.

WILL NREN MEET THE EDUCATION COMMUNITY'S NEEDS NOW AND IN THE FUTURE?

There is a severe disillusionment in the general population of the United States about the state of public education. Low SAT scores, an increase in student dropout rates, a decrease in the numbers of students pursuing college, and startling figures about the great number of illiterate Americans have all contributed to an intense scrutiny of our nation's educational policies, practices, and resources. Legislators, school administrators, teachers, and corporate executives have all grappled with reform efforts to make education more relevant and responsive to work force needs. Not surprisingly, technology as a tool for learning has become a key topic in all discussions of school reform. Educators around the country are scrambling to infuse telecommunications technology into every learning environment.

President Bush proposed a solution to the country's education crisis when he announced his America 2000 Education Strategy in April of this year. He also pushed information technology as part of the overall solution to education problems when he said:

> Operation Desert Storm was a triumph of American character, ability and technology—a victory for America and all it stands for. It helped show that our nation can do whatever it decides to do—and our people can learn anything they need to learn. Still, eight years after the National Commission on Excellence in Education declared us a "Nation at Risk," we haven't turned things around in education. Almost all our education trend

> lines are flat. Nor is the rest of the world sitting idly by, waiting for America to catch up. Serious efforts at education improvement are under way by most of our international competitors and trading partners. Yet while we spend as much per student as almost any country in the world, American students are at or near the back of the pack in international comparisons. If we don't make radical changes, that is where they are going to stay. While the age of information and communication technology rewards those nations whose people learn skills to stay ahead, we are still a country that groans at the prospect of going back to school.[9]

Proponents of technological solutions to solve education's woes, such as institutional computing, distance learning, instructional television, and electronic research and library gateways, have taken the President's challenge to heart, and argue that at a time of declining revenues, budget deficits, and resource shortages, a shared-cost broadband electronic highway is the only way that these solutions can be equitably spread to all educational institutions in the country.[10] The NREN coalition argues that once the network is built with federal funds, the more than 300,000 scholars and teachers currently using NSFNET and other regional networks would have enough capacity (3 billion bits per second) to meet our country's research needs in the 21st century.

Roger Karracker, in his excellent review of the issues surrounding the NREN debate, argues that high-level researchers may be in "hog heaven" over the proposed network's solutions to their problems, but he is less sanguine about NREN's promise for the rest of the education community:

> What can you do with 3 billion bits per second? The NREN coalition likens this transmission capacity to sending 100 three-dimensional x-rays and CAT scans every second for 100 cancer patients, or sending 1,000 satellite photographs to researchers investigating agricultural productivity, environmental pollution or weather prediction. Reduced to just words, it would be 100,000 typed pages per second, or as the coalition dangles tantalizingly before us, "making it possible to transmit the entire *Encyclopedia Britannica* in a second."

Karracker argues that this capacity may in fact be available only to the high-end research user and not to K-12, which is the focus for much of the clamor for technology access in the country.

Before you begin salivating at the thought of every book, every magazine article available instantaneously at your slightest whim, here's the rub: As currently designed, NREN's 3-gigabit data lines aren't coming to your house, or your kid's room, or even your local library. NREN would connect only the largest research universities and consortia, at least one in every state. From there, lower-speed regional net-works, which for the most part already exist, would connect nearby institutions. At the bottom of NREN's proposed three-tier system would be local college and university networks. There's no plan or provision for a technical hookup of K-12 schools or local libraries in the NREN proposal, let alone any of the training, customer premise hardware or courseware necessary to make technology infusion effective in a K-12 environment.

One doesn't need the vast capacity of NREN to exchange simple electronic mail. There are many alternative, if slower, networks available already. Using supersophisticated NREN for such mundane tasks might be like trying to get a drink out of a fire hose. And it is problematic whether local schools and libraries would be able to pay for the equipment needed to exchange items much more complex than simple electronic mail.

The major issue with NREN in its current form is that it creates a real potential for information haves and have-nots. As Apple Computer's Steve Cisler puts it, "If this is going to be a data superhighway, how would you like to have to drive to a computer, military base, or university to find an onramp?"[11]

Karracker raises the right issues, and his concerns were echoed by the Office of Technology Assessment (OTA) in an ongoing study it is conducting on NREN for Senator Gore.[12] Susan Rogers, director of the Office of Distance Learning at the Rochester Institute of Technology, agrees when she says: "The 'E' in NREN has not received much discussion beyond vague references to improving education and serving educational needs."[13]

The use of computer communication, data base access, and even distance learning through electronic networks is relatively new to education. Although early adoption of computers in school labs began

in the 1960s and early uses of satellite instruction began in the 1970s, the dramatic infusion of technology in schools began in the mid-1980s. OTA's most recent data suggests that schools' adoption of CD-ROM technology, laser discs, local area networks, satellite dishes, and modems is still at an early stage.

The preliminary research on test beds, model sites, and broader deployment indicate that technology is a powerful tool to expand and improve instructional efforts.[14] Can it stem the tide of dropouts, illiterate students, and overworked teachers? Linda Roberts, senior associate for Science Education and Transportation at OTA, argued that it could before the House Subcommittee on Technology and Competitiveness in June of this year:

> I can assure the committee that technology is beginning to play an important role in improving education in this country. There is no one best use of technology, but there are many promising applications for all learners—at risk students, the gifted, those with special needs, and others. The varied capabilities of the technologies are key to their power. OTA's assessments make clear that under the right conditions, new interactive technologies contribute to improvements in learning—from helping to build basic skills through drills to directing student discovery through simulations, to encouraging cooperative learning as students work together on computer projects in the classroom or on electronic networks across the world.

However, equal access to educational opportunities that technology resources afford is becoming a major concern in the education community. The costs involved in integrating technology into education's infrastructure are enormous, and at times of national- and state-level deficits and budget cutting, large capital expenditures for technology are very difficult to come by. It is for this reason that educators have jumped on the bandwagon of the NREN supporters.

Not surprisingly, they also support the federal "Star Schools" program and Whittle Communications "Channel One," which is a commercial, advertising-supported technology deployment in schools. In short, they are desperate for any kind of support to acquire technology so they can begin the massive task of teacher training and curriculum

reform essential to the successful infusion of technology into the learning environment.

WOULD EXTENDING NREN TO EVERY K-12 SITE IN THE COUNTRY REDUCE ITS BENEFIT TO THE RESEARCH COMMUNITY?

Initially, the objective of NREN was to "jump start" a high-level communications network to connect supercomputers and the nation's researchers with federal funds. It is industrial policy designed to maintain international competitiveness in science, math, and technology transfer. There is a clear, demonstrated need for a coordinating cost-sharing mechanism in this area. Most supporters of NREN argue that even the current slimmed-down version of the Gore bill that is working its way through Congress this session would satisfy this need. Others argue that this need alone is not enough to justify NREN and the sizable allocation of taxpayer dollars.

Dave Hughes, a Colorado telecommunications pioneer, takes a more cautious view of the slimmed-down NREN that Gore and others are trying to push through Congress. An ex-Army colonel and former aide to Defense Secretary Robert McNamara, Hughes believes that NREN's plan, with local schools not even mentioned, could perpetuate educational elitism, where already-prosperous research universities get additional taxpayer-paid subsidized service and already-poor local schools get short shrift. He argues that "the implicit assumptions behind the NREN proposal are that it will only link large research (which also may be 'educational' in the sense of higher education) institutions." As currently conceived, NREN will not extend to the 16,000 K-12 school districts in America, much less foster the vision of a nation of people learning all their lives by mixing institutional (edifice-centered) education and training with learning, formally and informally, from home, library, and place of business or study. Hughes concludes that "the metaphor of the need for 'highways of the mind' across this land is very deceptive. It really could turn out to mean 'super toll roads between castles.' "[15]

The funding levels proposed for NREN, whether you use the President's proposed $150 million, or Senator Gore's proposed $1 bil-

lion over five years, are simply not enough to extend NREN to the nation's 16,000 school districts or 80,000 school sites. Its initial design was to serve at least one research institution in each state and interconnect the federally supported supercomputer centers. Clearly, the first tier of service proposed by Gore's bill would meet the needs of this elite research community. The original National Research Network proposed by Gore in 1988 would have done that as well. When the "E" was added to NRN to become NREN, different expectations were created and different policy implications were set up.

You cannot have a debate on whether NREN should be extended to all school sites in the country without opening up the federal telecommunications policy morass. Congress, the FCC, and Judge Greene have been wrestling with these issues since 1984, and they have yet to resolve them. Before we resolve the NREN debate, we must ask whether all citizens of the United States should have access to broadband delivered services. Should we have an industrial policy that encourages broadband deployment of information services to every school or every home in America? If the answer to these questions is yes, then who is going to pay for the network? How fast should it be deployed? And where does NREN fit into this larger debate?

WHAT IS THE RELATIONSHIP OF NREN TO THE STRATEGIC OBJECTIVES OF NATIONAL PUBLIC TELECOMMUNICATIONS POLICY?

The decision to invest public resources in a major telecommunications project must be taken in light of national telecommunications policy objectives. The question that needs to be asked in conjunction with the NREN debate in Congress is: What is the strategic vision of the telecommunications infrastructure in the United States after the breakup of AT&T?

As I discussed earlier, the universal, public switched voice grade network mandated accessible by the Communications Act of 1934 still exists and is now operated by the seven regional Bell operating companies (RBOCS). However, the highly competitive environment in telecommunications created by the divestiture of AT&T, and the restrictions placed on the RBOCs by Judge Greene and the Justice Department

until July 25 of this year, precluded any immediate universal upgrade of the public network to the capacity proposed for NREN's connectivity for the research community. Unlike France, Germany, and Japan, we have no federal policy mandate or governmental funding for an enhanced universal service where every home, school, and business has access to smart, high-speed, broadband capability. As I asked earlier, Should we? I believe the answer is yes.

In the past, our postal, communications, rail, and highway systems were guided by a fundamental industrial policy objective of providing universal access to essential services. Many argue that our democratic form of government requires equity of access to all essential infrastructures. Has modern telecommunications technology reached the level of essential infrastructure, and should it be made universally accessible to every American? Many policy makers and scholars think that the time has come. Senator Larry Pressler (R-SD) says, "the means are at hand to provide full telecommunications services to all Americans. Universal service is and should be a guiding principle in directing U.S. telecommunication policy."[16] Alfred Sikes, the new chair of the FCC, is moving in the same direction: "We are looking to encourage more rapid, widespread deployment of advanced, multi-use technologies. A key to this accomplishment will be to break down the artificial regulatory constraints on their use."[17]

Should we try to stretch an underfunded NREN proposal to try to meet all of education's needs? Or should we all get behind a coherent telecommunications policy that would redefine universal service to include access to a broadband voice, video, and data network? The OTA investigations into these issues for Congress found that changes in the nation's communication infrastructure since divestiture are likely to increase the gap between those who can access communication services and information technologies and those who cannot. They argue that rising prices and difficulties in getting access to technology-based networks will create a whole class of citizens who are "information poor."[18]

As Karracker argues, What good is it to have access to technology resources only at a research institution when there is a pressing need at every K-12 site in the country? If President Bush, OTA, and the researchers in education reform are correct when they conclude that access to technological tools is essential to the successful reform of

our schools and to the maintenance of an educated workforce to guarantee global competitiveness, then the NREN debate must center on equity of access.

The education reform movement that is sweeping our country is concerned about this issue as well. Most of the reform movements stress site-based management, parental involvement, and equitable access to learning resources. A broader deployment of technology resources—industrial policy that supports broadband deployment to at least all education sites if not all homes—would better serve the focus of these reforms.

The cost to deploy a broadband voice, video, and data network to the entire country is much higher than the funds proposed for NREN. The cost estimates for such a deployment range from $20 billion to more than $200 billion.[19] The question of who pays is still the biggest issue. Should the United States encourage investment through regulatory policy? Should we invest federal dollars to "jump start" a broader deployment, the way Gore proposes for NREN?

Despite the unresolved cost issues, the real issue is who will have access to the highway. Mitch Kapor, co-founder of Lotus Development Corporation and president of the Electronic Frontier Foundation, believes that universal access must be a central tenet of any national network policy, otherwise the stratification of information haves and have-nots will lock in a permanent underclass.[20] I agree with him.

For me, the proposal to fund NREN forces Congress to create an interim solution for the sophisticated education researchers and their vested interests that will ultimately work against the longer-term strategic needs of the country. I believe that we must first achieve a consensus on the long-term objectives of telecommunications policy. France, Germany, and Japan have grappled with these issues and have determined that universal access is essential to their strategic interest. They have put policies and funding in place to enact their visions.

We need to settle those same issues before we make a specific decision about NREN. The issues are complicated and the solutions costly, but overall goals need to be a part of the design. The mandate of NREN or an expanded NREN must be consistent with the goals of public industrial policy, telecommunications policy, and educational policy.

I began this discussion with Ithiel de Sola Pool's caution that it is not the technology or specific regulations of it that are the issue. The real

issues at stake are equity, information access, and freedom. For me, the NREN debate in Congress is only one part of a much larger debate. We need to develop a vision of a telecommunications infrastructure for the 21st century that will meet the needs of not only the education community but all public and private sector users as well.

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TOWARD A UNIVERSAL DEFINITION OF UNIVERSAL SERVICE

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The monopolist's goal of nationwide telephone interconnection was transformed into the social goal of universal service, embodied in our nation's laws by the Communications Act of 1934, and putatively achieved in the last decade of the 20th century. The social and economic importance of knowledge to be gained from the rapid and efficient distribution of information, the emergence of the global economy, and the proliferation of competitive networks will necessarily alter the concept of universal service in order to serve our nation in the next century. This essay proposes several principals by which to re-define universal service.

EARLY VISIONS LEAD TO A SOCIAL POLICY

Alexander Graham Bell can be credited with the dream of universal telephone service. Unlike the nation's first communications monopoly, the telegraph, which was shaped by Morse's early partners and by Western Union as a service to be provided to business, Bell had a distinctly different view. In his forays throughout New England in the spring of 1877 promoting his telephone, he predicted that in time "a telephone in every house would be considered indispensable. . . ."[1]

The Indispensable Household Appliance

Bell's vision went considerably further. In a letter to a group of British investors in 1878, he wrote:

> At the present time we have a perfect network of gas pipes and water pipes throughout our large cities. We have main pipes laid under the streets communicating by side pipes with the various dwellings, enabling the members to draw their supplies of gas and water from a common source. In a similar manner it is conceivable that cables of telephone wires would be laid under ground, or suspended overhead, communicating by branch wires with private dwellings, counting houses, shops, manufactories, etc., uniting them through the main cable with a central office where the wire could be connected as desired, establishing direct communication between any two places in the city. Such a plan as this, though impracticable at the present moment, will, I firmly believe, be the outcome of the introduction of the telephone to the public. Not only so but I believe in the future wires will unite the head offices of telephone companies in different cities, and a man in one part of the country may communicate by word of mouth with another in a distant place.[2]

Bell's vision was reinforced by the scheme his investors found necessary to market the early telephone. On July 9, 1877, less than a year after Bell had filed for his patent, Bell's partners, who had helped finance his initial experiments, organized the Bell Telephone Company of Massachusetts. Gardner O. Hubbard, who had become Bell's father-in-law upon Bell's marriage to Mabel Hubbard just four days after the founding of the firm of which he was president, had been an investor in several shoe and shoe machinery manufacturing enterprises in New England and was well versed in the process of leasing machinery while holding the patent rights to the inventions. Unable to obtain sufficient capital from his fellow bankers in Boston, Hubbard applied this know-how to his son-in-law's invention. Hubbard toured the oil fields of Pennsylvania and the industrial centers of New England, enlisting agents who, in turn, would franchise the telephone in these markets. Contracts were drawn with the franchisees to lease the company's equipment to customers in return for an annual commission of 40 percent on each

telephone for the first year and 20 percent thereafter. Anyone with $200 and a talent for tinkering was given a license to construct a telephone system—and the United States was a nation of inventors and tinkerers. Within a year Hubbard had negotiated agreements for Boston, Albany, and New York; had concluded temporary arrangements for the rest of New England; had found agents for western New York state, Ohio, Indiana, and the oil fields of Pennsylvania; and had completed terms for South Carolina, Georgia, and the northern sections of Florida. Five years after the telephone patent had been issued to Bell, there were local telephone companies throughout the Northeast, the South, and the Midwest in cities, towns, and villages and on farms.

Bell's telephone was a relatively simple device easily installed by anyone with do-it-yourself talents. Hubbard's pricing policies were designed to attract both business and residential customers and he was succeeding beyond his greatest expectations. By the end of 1878 there were about 10,000 Bell telephones in the United States and the Bell Telephone Company, as it was now called, was involved in numerous patent disputes from which the company emerged victoriously, essentially as a monopoly.[3]

Sociability on the Telephone

Unlike the very early advertisements for the telegraph, those for the telephone stressed its use for social purposes and for connecting dwellings with other dwellings and business offices. The cost was $20 per year for residences and $40 per year for businesses, payable in advance. Despite this initial focus, subsequent advertising campaigns sought to discourage the social uses of the instrument. They even went so far as to suggest that excessive chatting by housewives would seriously disrupt the system from being available to more important business uses. Despite pricing policies that discouraged non-business telephone use, the public designed its own uses for the telephone and increasingly the telephone became a household instrument for sociability.[4]

Universal Means "Everywhere" Rather than "Everyone"

Switching was introduced in 1878, transforming the telephone from limited point-to-point communications to the more attractive service that enabled any subscriber to talk to any other subscriber on the same

exchange. Licensees were encouraged to interconnect their exchanges, thereby increasing the attractiveness of telephone service to the subscribers. But the licensees found this difficult because of the differences in the way they had designed their exchange and telephone wiring.

Theodore Vail joined the company as its first general manager. He had worked for the postal service and recognized that a universally interconnected system would capture more subscribers. Quickly learning from the ongoing and often frustrating experiences of the franchisees in trying to accommodate a jungle of different standards, he saw the necessity for a single system under a single standard. With the assistance of technicians dispatched to the franchisees to oversee interconnection, Vail embarked on the construction of toll circuits or long-lines. To Vail, at this time, "universal service" was the interconnection of these local exchanges. "Universal" implied "everywhere" rather than "everyone."

HOW THE MONOPOLIST'S GOAL FOUND ITS WAY INTO AN ACT OF CONGRESS

Theodore Vail's goal was interconnectivity among the many local telephone companies in the nation, whose number had grown considerably during the period of intense competition from 1894 through 1907 following the expiration of two fundamental Bell patents in 1893 and 1894. Indeed, by 1900 some 2,000 independent telephone companies controlled 38 percent of the installed phones in the United States. In 1906 only about 300,000 of 2.16 million independent telephones were connected to the Bell system.

Competition Challenges Theodore Vail

This period of competition saw the most rapid growth of telephone service during the early history of the telephone. The independent operators increased their telephones by 22 percent while Bell increased its by 62 percent. But during the period of mergers Bell system growth was much smaller, dropping from an average of 21.5 percent from 1895–1906 to an average of 9.6 percent from 1907–1912.[5] Mergers actually decreased interconnection, for while many smaller companies were interconnected by joining Bell, they were disconnected from their former partners.

The development of the long distance network was perceived as a means for reducing this competition, and these companies barred Bell from establishing a nationwide monopoly.[6] Interconnection would lead to greater ability for AT&T to acquire the smaller telephone companies and, further, to convince these companies of the benefits of acquisition as a means of capitalizing on their initial investments. Vail envisioned a single national network as being in the public interest as well as in the interest of AT&T.

Aggressive Acquisition Leads to an Anti-Trust Suit

Vail's aggressive acquisition policies came to the attention of the Department of Justice and in 1912 it began to monitor AT&T's acquisitions. Attorney General Wickersham wrote to the chairman of the Interstate Commerce Commission urging the ICC to open an investigation of the telephone industry in 1913. Wickersham argued that "the value of a telephone service depends largely upon the facility of connecting every individual telephone user with any point upon any telephone line in the United States but this should be attained under conditions which secure to the public the most reasonable terms consistent with a fair return upon the investment and under suitable supervision and control by your honorable body."[7]

The Justice Department filed an anti-trust suit in the Federal District Court in Oregon attacking AT&T's interconnection and acquisition policies, and sought redress by requiring the divestiture of the properties Bell had recently acquired in that state. On December 19, 1913, Nathan Kingsbury, first vice president of AT&T, signed an agreement to refrain from acquiring competing telephone companies without explicit approval from the Justice Department, and to provide long distance interconnection to independent companies not yet connected to the Bell network.[8] Vail accepted regulation in return for stability for his company and for the right—indeed, the requirement—to interconnect independent telephone companies. Interconnection was the open door for the AT&T monopoly and for the provision of universal service, which was simply interconnection for the delivery of a single service, the dial tone for the transmission of voice communications, or what has become known as "plain old telephone service."

Universal Means "Everywhere and Everyplace"

The seeds of a broader concept of universal service were planted. When Vail perceived the benefit of further interconnection as a means to forestall competitors, and as he explained the importance of this concept to sell his version of a telephone monopoly to Congress, he stressed interconnection not only "everywhere" but to "everyone." In the 1910 AT&T Annual Report Vail wrote:

> It is believed that the telephone system should be universal, interdependent, and intercommunicating, affording opportunity for any subscriber of any exchange to communicate with any subscriber of any other exchange. . . . It is believed that some sort of connection with the telephone system should be within reach of all.
>
> It is not believed that this can be accomplished by separately controlled distinct systems nor that there can be competition in the accepted sense of competition.
>
> It is believed that all this can be accomplished to the reasonable satisfaction of the public with its acquiescence, under such control and regulation as will afford the public much better service at less cost than any competition or government-owned monopoly could permanently afford and at the same time be self-sustaining. . . .
>
> With the extension of speaking limits of the telephone over connecting lines came also the necessity for standardization, uniformity of apparatus and operating methods and an effective common control over all. The necessity for [such a] system was the beginning of the Bell system. . . .
>
> It is impossible to define the territorial limitations of a telephone system because from every exchange center communications is wanted up to the talking limits in every direction.
>
> This process of combination will continue until all telephone exchanges and lines will be merged either into one company owning and operating the whole system or until the number of companies with territories determined by political, business, or geographical conditions, each performing, will be closely associated under the control of one central organization exercising all functions of centralized general administration. . . .

> The Bell system was founded on broad lines of "One System," "One Policy," "Universal Service" on the idea that no aggregation of isolated independent systems not under common control, however well built or equipped, could give the country the service. One system with a common policy, common purpose and common action; comprehensive, universal, interdependent, intercommunicating like the highway system of the country, extending from every door to every other door, affording electrical communication of every kind, from every one at every place to every one at every other place.[9]

Vail's statement became the springboard for corporate and national policy. AT&T adopted a pricing policy that would ensure access to every one and every household at reasonable cost across the nation. Wherever one lived calls traveling the same distance carried the same price. "Nation-wide average pricing," as this was called, purposely did not take into account cost differences on different routes nor the costs of the individual service. In effect, customers on low-cost routes were subsidizing those on high-cost routes.

Ensuring Universal Service by Radio

Wireless communications had not been overlooked by Congress in the desire for universal communications services. In the early decades of this century Congress wished to ensure that the early radio stations would serve the entire nation, not only the major cities on the East Coast and the more highly populated areas of the country. By 1927 broadcasters had established more than 700 radio stations during the hectic early days of radio when there were no allocation rules, and had gained a small but loyal listening audience, which was growing. It was clear, however, that vast areas of the nation, in the South and West and in the rural areas, were likely to be left out of radio because they did not, at that time, offer attractive markets. Fearing that stations would be monopolized by the major cities where broadcasting was most profitable, Congress passed the Davis Amendment (to the Radio Act of 1927), requiring the Federal Radio Commission to equalize, as nearly as possible, the number of stations, their power, and their time of operation among five zones into which it divided the country. Stations

were to be allocated to each zone evenly among the states. Further Congress stated two additional goals: (1) to provide a local station for every community in the nation that could economically support one, and (2) to serve the rural portions of the nation as well. Thus was born the idea of localism in broadcasting, a cousin of the concept of universal wire communications services. Universal service, by wire and radio, at affordable costs, was embodied in the act that established the Federal Communications Commission (FCC)

> [f]or the purpose of regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all people of the United States a rapid, efficient, nation-wide and world-wide wire and radio communication service with adequate facilities at reasonable charges for the purpose of the national defense, for the purpose of promoting safety of life and property through the use of wire and radio communication. . . .[10]

THE PERSISTENCE OF THE GOAL OF UNIVERSAL SERVICE

The provision of high-quality universal telephone service became a corporate tradition at AT&T. For the public it was perceived as an entitlement, if not a right. AT&T pursued this argument throughout the anti-trust suit which the federal government filed in 1974.[11] In a paper commissioned by AT&T, Eugene V. Rostow, who had chaired President Johnson's Task Force on Communications Policy, suggested that one of the fundamental policies of the Communications Act of 1934 and its predecessor statutes was to assure the maintenance and development of the integrated switched telephone network managed by the Bell system in cooperation with the 1,600 independent telephone companies. Further, Rostow argued that this "unitary" network, whose facilities are available in common to all users, is at the heart of the mandate of the Communications Act. Congress, he wrote, chose this means rather than a competitive structure or a utility model as the most cost-effective way to serve the public interest for the provision of universal telephone service.[12]

Divestiture Threatens the Corporate Tradition and the Public's Entitlement

Fearing increases in local service costs with subsequent sharp increases in disconnects upon the AT&T divestiture, especially among the poor and the elderly, the Universal Telephone Service Preservation Act of 1983 (HR 4102) was introduced in the House of Representatives. It was never enacted. Residential service rates did rise following divestiture, in part because of the high inflation levels across the entire economy in the years preceding divestiture. However, there was little concern about households discontinuing service because the price elasticity of demand for access was and remains remarkably low. One estimate based on 1980 census data claims that a doubling of the price of telephone service would result in a 3.2-percent decrease in telephone penetration.[13] There are, however, wide variations in price elasticity of demand for households by income classes. For below-poverty-level households headed by a husband and wife of age 65 and older, a doubling of the price would be expected to reduce telephone subscription by 2 percent, while subscribership could fall as much as 20 percent for below-poverty-level males of age 25 and younger.[14]

Significant increases in local service rates occurred in 1985, 1986, and 1987 with the imposition of subscriber line charges, flat access charges paid directly by subscribers, in part for long distance usage. Because state regulators are particularly sensitive to local subscribers, concerns for the maintenance of affordable rates was quickly expressed by state utility and public service commissions and in state legislatures. In 1983 California initiated a legislative process that resulted in the "Moore Universal Telephone Service Act" which was signed into law in late September of that year. Customers with incomes below a specified level receive a 50-percent discount on basic local service along with other benefits. The program is financed by a 4-percent surcharge on certain intrastate telephone services. Subscribership to the California program grew from 489,358 as of December 1984 to 1,106,960 as of April 1987.[15]

Telephone Assistance Programs When the Market Fails

In mid-December 1984 the FCC adopted a plan which allowed a total reduction in fixed charges for telephone service to offset 50 percent of the federal subscriber line charge (SLC) for low-income households

satisfying a means test subject to verification. This waiver was raised to 100 percent of the FCC SLC the following year. Thirty-one states currently participate in the FCC Lifeline program while others have state programs similar to the FCC program. These programs are funded through charges paid by interstate rate payers and reflect matching local rate reductions approved by state utility commissions.

Recognizing that subscribership is often discouraged by high installation charges as well as high monthly rates, in April 1987 the commission adopted a program to partially offset these charges. Eligible subscribers benefit from a government subsidy of up to $30 to offset one-half the charges for beginning service, and local telephone companies are encouraged to offer deferred payment plans for the remaining charges. State participation has been even greater than that for the FCC Lifeline assistance programs.

With data provided by the companies participating in Lifeline assistance programs, the FCC estimates that as of October 1990, 2,213,316 low-income subscribers receive reduced rates under the federal Lifeline assistance program and more than 142,000 low-income households have access to the telephone network through the Link-Up America connection assistance program.[16]

States Play a Major Role

Regulation of local telephone services, including the maintenance of universal service, has been thrust almost entirely on the state regulators. Several states have altered their eligibility requirements while others are experimenting with other means to ensure high-quality universal telephone service. Regulators are faced with the task of developing policies that permit upgrading the network for the development of advanced telephone services called integrated services digital network (ISDN) and eventually broadband ISDN (B-ISDN), while maintaining the Communications Act's goal of universal service at reasonable costs. States continue to affirm their commitment to Bell's long-standing universal service goal and to public policy; for example, the New York Public Service Commission announced that they maintained "an undiminished commitment to universal service, maintenance of high quality service, continuation of adequate forum for resolving consumer concerns. . . ."[17] The California Public Service Commission stated that it ". . . recognizes universal service as a priority objective . . . that no

changes in regulatory structure should threaten the affordability, availability, and quality of basic telephone services for all California ratepayers. . . ."[18] When Idaho established its universal service fund it also stated that it is committed to the goal of universal service, "that the telephone network binds society together and is essential for individuals in contacting persons, businesses, and emergency assistance personnel."[19] However, a report of the National Consumer Law Center noted that in discussions of social contracts and other forms of deregulation and competition, universal service is often treated as an afterthought. Lifeline and Link-Up programs are offered as remedies for failures in rate design and regulation. The legal mandate for universal service in the Communications Act is, according to the report, "the single most important consideration in devising any telecommunication policy ensuring that the entire population has telephone service."[20]

Has Universal Service Been Achieved?

The consequences of these policies today is a nation in which 93.3 percent of all households have at least one telephone (95 percent of all households have access to a telephone) and in several states 97 percent of all households have one or more telephones which, except for Sweden, is the highest rate in the world.[21] The number of households in the United States increased by 10.4 percent between November 1983 and November 1990. During this same period the percentage of households with telephones increased by 12.7 percent and the number of households without telephones decreased by 14.9 percent[22] (see Table 1).

What of the Households Without Telephones? Nevertheless, there are large pockets of households that do not have telephone service. Of the 94.7 million households in the United States (as of the November 1990 Current Population Survey), 6.3 million, or 6.7 percent, do not have access to telephones. Several states have penetrations far below the national average (see Table 2). Telephone penetration for households with a yearly income less than $5,000 headed by blacks between the ages of 16 and 24 was at 66.4 percent, with those headed by Hispanics between the ages of 16 and 24 at 67.8 percent. Generally, young families with incomes below the poverty line have the lowest telephone penetration, contrary to the widely held belief that the elderly have the lowest telephone penetration rates (see Table 3).

Table 1 Telephone Penetration in the United States

	Households	*Households with phones*	*Percent with phones*	*Households w/o phones*	*Percent w/o phones*
	(millions)			*(millions)*	
1983	85.8	78.4	91.4	7.4	8.8
1984	87.4	79.9	91.4	7.5	8.6
1985	88.8	81.6	91.9	7.2	8.1
1986	89.9	83.1	92.4	6.8	7.6
1987	91.3	84.3	92.3	7.0	7.7
1988	92.6	85.7	92.5	6.9	7.5
1989	93.9	87.3	93.0	6.6	7.0
1990	94.7	88.4	93.3	6.3	6.7

Source: Monitoring Report CC Docket No. 87-339, Staff of the Federal-State Joint Board, in CC Docket No. 80-286, Washington, DC: Federal Communications Commission, January 1991, p. 13

In low-penetration states such as New Mexico, Alaska, Oklahoma, and Mississippi there are areas in which telephone services are not being offered. Franchised telephone companies did not interconnect households because they believed either that there was no suitable market for telephone services or that the very low household density would make the cost of extending service too high when compared to the expected returns. Our best estimate is that access to service is not available to

Table 2 Telephone Penetration in Selected States

	Telephone in Unit *(Percent)*	*Telephone Available* *(Percent)*
United States	93.3	94.9
Alaska	86.8	89.9
Arkansas	87.5	91.0
California	94.9	96.0
Connecticut	98.1	98.5
Idaho	92.5	93.6
Iowa	96.3	97.5
Mississippi	85.5	90.3
New Mexico	85.8	89.6
New York	92.3	94.0
Oklahoma	88.2	91.2
South Carolina	87.8	90.8
West Virginia	86.8	90.3

Source: Same as for Table 1, p. 21

Table 3 Telephone Penetration Rates by Income, Age, and Household Type (In percent)

Household type/ age	*$3,491*	*$8,636*	*$15,152*	*$20,761*	*$44,822*
Male individual					
25	53.32	66.66	78.88	85.58	95.18
45	73.19	83.24	89.27	92.75	97.36
65	86.71	91.47	94.88	96.50	98.56
Female head/ 2 children 6 and 12 years					
25	84.24	90.34	94.59	96.53	98.93
45	92.74	95.59	97.50	98.36	99.42
65	96.83	98.05	98.86	99.23	99.69
Husband & wife					
25	79.05	86.85	92.50	95.15	98.49
45	90.01	93.86	96.49	97.69	99.18
65	95.56	97.26	98.39	98.91	99.56

Source. L.J. Perl, "Residential Demand for Telephone Service, 1983," White Plains, NY: National Economic Research Associates, December 16, 1983, p. 14

about 2 million households. While the Communications Act of 1934 and the many items we have noted attest to the importance of telephone services for social as well as economic reasons, state regulators appear not to have pressed their franchisees to extend service to remote areas and to pockets of poverty. Universal service funds and other assistance to low-income households might very well make service to these households economically feasible. In some areas competitors have entered these unserved markets, often using lower-cost technology such as BETRS[23] to reach these communities despite the challenges from the franchised carriers. These challenges further delay the delivery of telephone services. It is unclear whether the FCC has stated a position on this issue but, in any case, its powers *vis-à-vis* state regulatory and legislative bodies may be limited. The issue of state versus federal authority not only over the provision of universal service but also over the upgrading of nation's telecommunications infrastructure needs resolution if universal access to telephone service for those who want a telephone is to be achieved.[24]

At any given survey period approximately 20 percent of households may be temporarily without telephones because of relocation. Few if

any studies have accurately determined how many households capable of purchasing telephone service do not do so because of inability to pay. Nolan Bowie estimates that in 1987 there were more than 5 million households without service because of inability to pay.[25] Our estimates are that in 1990 there may have been about 3.4 million households that had access to telephone service but did not have service. While there may be other reasons for not wanting a telephone, many of these households had other more pressing needs such as food and medical care and could not afford to pay for telephone service.[26]

Following the AT&T divestiture, residential local rates did increase significantly, in part due to the imposition of the subscriber line charges and in part in response to rate increases granted to the operating companies by the states. Between January 1983 and December 1990, unlimited local calling monthly rates increased by 51 percent while the lowest generally available monthly rates increased by 73 percent. During the same period, minimum connection charges increased by about 22 percent. On the other hand, long distance rates have been reduced by about 40 percent. In 1990, subscribers qualifying for Lifeline assistance were paying 11 percent more for unlimited calling, 36 percent more for the lowest generally available rate, and 44 percent more for connection charges. Local rates are regulated by state regulatory agencies, and many of these states have continued the traditional policy of charging higher rates in the urban areas than in rural areas, a policy that recognizes that the more people with access to the network the more valuable is telephone service for the consumer, and urban consumers reside in more populous calling areas. Despite these rate increases, telephone assistance programs have demonstrably contributed to the increase in telephone penetration (from 91.4 percent in 1983, just prior to the increase in telephone charges, to 93.3 percent in 1990) and to the reduction in the percentage of households without telephones (from 8.6 percent in 1983 to 6.7 percent in 1990).

DEFINING UNIVERSAL SERVICE FOR THE NEXT CENTURY

Universal telephone service was made possible by general and almost universal network interconnection, and network interoperability was relatively easy to define when voice message communication was

the only service offered by a monopoly provider.[27] When the market could not achieve universal service, subsidies and tariff policies were designed to further and maintain universal telecommunications services. But there have been significant changes in society, in technology, and in economics that now make the task of defining universal service much more difficult:

- Information has become the most valuable currency of our society, if not of the world, as nations strive to become information economies;
- nations must compete in a global market and telecommunications has become both the transportation and distribution routes for this market; and
- domestic and international markets can no longer be served by well-defined single-function telecommunications networks, but rather must be served by many multi-purpose, often competitive, public and private networks providing voice, data, video, and images, over wire and by radio.

Universal service has come to mean more than access to a dial tone at reasonable cost: Quality of service; provision of single-party rather than multi-party lines, especially in the rural areas; the expectation of privacy; and, in some states, touch-tone dialing rather than rotary dialing are the norm. The telephone is no longer "plain" nor "old"; discretionary services such as call waiting, call forwarding, three-way calling, voice mail, call blocking and, in some areas of the nation, caller identification have significantly increased the usefulness and value of the telephone.

The Telephone is the Gateway to the Information Society

The telephone is the indispensable gateway to the world of information, important to the nation and to our daily lives, and without which information economies could not prosper. Lifting the information services restrictions imposed by the modified final judgment on the regional Bell operating companies very likely ensures that, in time, information services for education and facilities management; security monitoring for small and medium-sized businesses, households, and the

disabled; and protocol conversion to allow easy access to multiple information networks and other non-voice services will be available.[28] With the introduction of fiber into the public switched network, broadband services or a "video dial tone" could be the norm in the future. The infrastructure of the next century will be an information infrastructure rather than a communications infrastructure. How do we define universal information service? Must we not first ensure interconnectivity and interoperability of these information networks, especially if they are common carriers?

A Global Economy Requires Global Telecommunications

The global infrastructure of the next century will also be an information infrastructure, with satellite and fiber networks as the transportation and distribution highways. Europe, the Western Hemisphere, and Japan are developing digital information highways with the aim of providing for social integration and economic growth. How do we define universal service in the context of global telecommunications? And what of global interconnectivity and interoperability?

Networks of Networks

Private networks have spread throughout the United States and are now becoming a significant trend overseas. While many of these networks are designed to serve the special needs of large firms, there are incentives for such networks to serve other groups, for example, schools, political groups, and other special interest groups. While these "affinity networks" are not likely to be common carriers, there may be public-interest reasons they should be interconnected with and provide universal access to the public network. Consider, for example an education network for K–12 schools for accessing information and sharing research and teaching innovations. Parents are integral to the learning experience, and their access to the education network would be in the public interest. Similarly, a network to enhance political discourse among interested citizens would contribute to greater political participation if interconnected with the public network.

The next century will see an expanded use of digital radio and proliferation of personal communications systems, systems which will compete with the franchised and regulated regional Bell operating companies. Further, the cable/telco debate may be resolved by per-

mitting cable to offer telephone service in return for telephone entry into video distribution to the home. If personal communications systems and cable operators are to be common carriers and offer service without discrimination, they must interconnect with each other and with the regional Bell operating companies. This requires adherence to standards and a degree of universality that the competing firms may be unable to afford. Yet interconnectivity not only facilitates market entry but also makes the provision of universal service easier. Clearly, ensuring interconnectivity is a prerequisite for achieving universal service.

VALUES THAT LEAD TO THE GOAL OF UNIVERSAL SERVICE

Without a better definition of the objectives we hope to achieve through the universal provision of telecommunications, including information services, we have no way of knowing if we have achieved what Bell, Vail, and the Communications Act of 1934 set out to achieve. Can we say, today, that we have achieved universal service when young low-income families constitute a major portion of the almost 3.5 million households without telephones? Yet the telephone may spell the difference between a job and unemployment for these families. And many low-income families, including those receiving telephone assistance, believe some of the discretionary services are important to their safety and welfare.[29] Indeed, surveys of why people disconnect have found that inability to pay for their discretionary services is often given as reason for non-payment of a monthly bill.[30]

The old ground rules for universal service are no longer valid. We need to re-examine those values that brought us to the awareness that universal telecommunications and information services are important.

Democracy and Communications

It is not at all unusual for heavy telephone users to protest the introduction of measured service with the argument that their use of the telephone at a flat rate is their "right." Indeed, the fear of a massive reaction to measured service pricing is so great that despite evidence that most users would benefit from this pricing mode, state utility commis-

sions have rarely if ever allowed such pricing to be introduced.[31] The threat of the Superbowl or the World Series leaving over-the-air broadcasting for pay-per-view cable has raised the question of whether television should be universally available. Growing interest in personal wireless communications systems is focusing attention on the enormous bandwidth used by over-the-air television and thoughts are turning to cable as the preferred medium for fixed point-to-point television broadcasting. With 80 percent of the nation wired for cable and cable penetration hovering at about 60 percent of the nation's households, how universally available will broadcast television be?

The Founders Recognized the Importance of Communications. Neither telephone service nor over-the-air "free" TV is a right inscribed in the Constitution. However, the founding fathers understood the importance of communications among the scattered communities across the vast distances of the original colonies and spoke to this in several ways. Franklin proposed and the Constitution gave Congress the power "to establish Post Offices and Post Roads."[32] While the initial purpose of this was to provide government with low-cost delivery of documents, it was the origin of the nation's postal monopoly. As a common carrier, the postal monopoly was also a source of revenue when the government began carrying the mails. Until the 1820s the Post Office was in the Treasury Department as a producer of revenue, but public policy promoted it to a government department with the goal of extending development to all parts of the country at a more rapid pace. It was understood that a social goal of the postal service was the diffusion of knowledge, and newspapers, books, and magazines were given large subsidies in mail rates.

The First Amendment made it clear that communications was to be unregulated by the federal government and the Fourteenth Amendment extended the concept to the states: citizens were to be unrestricted in their communications. When Jefferson was elected president in 1800 he used his power to promote a newspaper favorable to his administration. Other politicians of that day believed it was proper for government to build up a press, despite the First Amendment. Further, Jefferson expressed a firm belief that an informed society was necessary for the maintenance of the democracy. All this points to a fundamental belief in the importance of communications and of access to information for all of its citizens.

The Power of Associations. In yet another way was communications seen as necessary to our form of government and for the maintenance of the unusual society being developed in the New World. De Tocqueville noted that "in a democratic society, the individual is powerless whereas in aristocratic communities there are a small number of powerful wealthy citizens among the many powerless who undertake and can achieve great undertakings. . . . In aristocratic societies, men do not need to combine in order to act, because they are strongly held together."[33] But Americans must develop associations to maintain and grow their civil life.

> . . . The political associations which exist in the United States are only a single feature in the midst of the immense assemblages of associations in that country. Americans of all ages, all conditions, and all dispositions, constantly form associations. They have not only commercial and manufacturing companies, in which all take part, but associations of a thousand other kinds, religious, moral, serious, futile, general or restricted, enormous or diminutive. . . .
>
> If it be proposed to inculcate some truth, or to foster some feeling by the encouragement of a great example, they form a society. Wherever, at the head of some new undertaking, you see government in France, or a man of rank in England, in the United States you will be sure to find an association.[34]

De Tocqueville goes on to say that if men living in democratic countries had no right and no desire to associate for political purposes, their independence would be in jeopardy but they might preserve their wealth. But if they never acquired the habit of forming associations in ordinary life, "civilization itself would be endangered. . . . If men are to remain civilized, or to become so, the art of associating together must grow and improve in the same ratio in which the equality of conditions is increased."[35] Associations are created and maintained through communications networks, interpersonal and mediated, and by the transfer of information. Without communications these associations would be weak and short-lived to the detriment of democracy.

Universal Service is a Prerequisite for Direct Democracy. Our definition of democracy has traditionally been one of a society in which there is full and informed participation by the public. Many observers of the political scene in the United States, viewing political campaigning via television and recognizing the low voter turnouts in both national and local elections over the past 30 or more years, have argued that American democracy has essentially disappeared. Indeed, some pessimists or cynics (perhaps realists) suggest that political stability is achieved only by the fact that voter turnout is low. And even if turnout were larger, others suggest that gatekeepers would shape information in a manner that would simply allow the people to act more or less intelligently but still in ignorance.

To counter this trend are proposals for achieving direct democracy electronically, via the telephone and the computer. Clearly, access to the telephone and to information by all citizens is a prerequisite for electronic democracy. However, there are problems with electronic democracy. For example, there is the danger of information overload, "the overexposure to information [which] destroys our critical and imaginative reactions," says Jacques Ellul. "The multiplicity of different media invades our communication capacities, surrounding us with a world of purely fictional information. Our experience of the real world disappears almost completely in a flood of information. The aspects of life which become most important are those transmitted through the magic of the screen. The rest is of little consequence."[36] Ellul may be referring to the computer screen as well as the video screen.

The plurality of information does not necessarily close the inequality gap that exists between those who have access to the means of transmitting information and those who do not. Free speech is available only to those that have access to the means of information transmission, whether it be via television or via information networks.

Community and Communications

De Tocqueville's associations were communities, and the vision of the United States as a nation of communities and neighborhoods continues today, even if as a nostalgic dream. In recent years the nature of the family unit has changed and the nuclear family has disintegrated, as young people move throughout the nation and the world for their work and divorce becomes an accepted means of solving marital

disputes. What a neighborhood or community is has long been debated by sociologists and political scientists. Definitions abound: A community is a social unit in a local territory, an ecological unit, a legal or administrative unit, a political entity, and even an idea or a process.[37] A more recent study suggests that a community may be a network of several persons linked by their need for mutual aid and support, a cooperative relationship serving all members of the community or neighborhood. This is a personal community, in which geography is less important than the links or ties each of the persons has in common with others. Indeed, the long debate over the death of community may have ended when the geographical measures of community gave way to the notion of personal communities.

Mediated Interpersonal Communications Facilitates the Maintenance of Personal Communities. Next to face-to-face communication, mediated interpersonal communication by telephone has become the most frequently used means for maintaining relationships or ties. Social researchers have found that income determines, at least in part, the nature of the relationships established. Upper-income and more highly educated people use these weak ties more readily than do lower-income, less-educated people; the latter depend heavily on family and kin. And the telephone is important to the creation and maintenance of those kinds of ties (the so-called weak ties) that are most useful for job seeking.[38]

The maintenance of community, of neighborhood, even if unbounded by geography, is important to our society, and, consequently, we have accepted the social responsibility of making basic telephone service available to all citizens of the nation. To do so we have chosen to trade economic efficiency for social benefit. We recognize that there are flaws in our telephone assistance programs, unintended consequences of public policy. For example, while the low-income elderly have traditionally been the target of many assistance plans, the evidence shows that they are the least likely to discontinue service when faced with a budgetary crunch. It is the low-income families in the 16–24 age group that are least served and most likely to discontinue service in hard times. Assistance to meet monthly telephone payments is a form of welfare, and welfare payments ought not be earmarked for a specific service. The qualified welfare recipient should determine how to allocate welfare payments.

Sharing Information in a Marketplace of Ideas

What of universal service in the information age? Communications is a sharing process and information is shared. Media or the channels of communications are necessary, but they are not sufficient for creating community or associations, for political participation and social intercourse. The founding fathers were not merely concerned with providing the means of communications. There is a great deal of evidence that the sharing of information in a marketplace of ideas was to be encouraged and made available to all.

However, information is increasingly being viewed as a valuable commodity. There has always been a cost for gathering information: a telephone call, a letter, or a visit to a public library requiring time and transport. Converting data to information and preparing that information for dissemination is not a cost-free task, and those who do so wish to market their information. Government information formerly available at no cost now carries a price, a practice that has come under attack by many citizens groups. While some limited information can today be obtained by a telephone call,[39] the telephone cannot be used for accessing non-verbal information that may be of greater value to the user. Today's communications infrastructure requires an intelligent terminal to access information, a computer that is a great deal more expensive than the plain old telephone.

UNIVERSAL SERVICE AND THE INTELLIGENT NETWORK IN THE 21st CENTURY

There is every reason to believe that the nation's telecommunications network will be well on its way toward an end-to-end-digital and fiber network by the end of century. Line haul and major trunk networks are rapidly being converted from the twisted pair and cable to fiber-optics.[40] New central office switch installations are increasingly digital,[41] and by the mid-1990s the cost of fiber-to-the-home is expected to fall to that for copper ($1,200 to $1,500/household) and the regional Bell operating companies will add the conversion of existing plants to the already fibered new plants. Spectrum abundance will replace spectrum scarcity on the wire and over-the-air. Networks capable of providing switched access to broadband information services including video

services could be available to every household. Today's audio dial tone will be replaced by tomorrow's "video dial tone." Communications will be by wire and by radio, interchangeably.

Maintaining the Social Policy of Universal Service

Making social policy has been frowned upon in the United States. We prefer to depend upon the marketplace for shaping social policy. However, the framing of the policy for universal communications services is one of very few social policies enunciated by Congress. Competition has been introduced in our telecommunications industries, placing them on the same market footing as the information industries. Increasing competition for the largest customers in the local loop will certainly put pressure on the revenues of the local companies and will force them to reexamine their universal service offerings. Competing local-loop fiber optic firms, for example, may have no incentives to interconnect with residences or small- or medium-sized businesses. Yet they draw revenue away from the public system, thereby making it more difficult for the public network to support universal service goals. It is necessary to find a way to fulfill the social policy stated in the Act of 1934 within this new economic climate—no easy task.

Providing Access to the Dial Tone and Broadcast Signal. The policies established to provide universal service are essentially policies to provide access—to the dial tone and the broadcast signal. But there is no policy that *guarantees* access to that broadcast signal. Should the broadcaster decide to provide an encoded signal available only to those who pay a fee, the broadcaster is free to do so. Should the Superbowl or World Series promoters choose to use cable to distribute these events, they are free to do so.

To Discretionary and Information Services. The telephone customer has access to non-verbal information sources provided the subscriber has the terminal equipment capable of accessing these data bases and, further, has subscribed to them. The marketplace has effectively provided relatively low-cost access to the audio dial tone (a telephone capable of accessing this signal can be purchased for as little as $20), but the regulatory constraints on the nation's telecommunica-

tions infrastructure mean a relatively high-cost intelligent terminal/computer must be used to access on-line data.[42]

The nation's telephone companies have essentially wired their regions and now seek to increase revenue per line. Discretionary and information services are revenue producing. While information services are generally too high priced, because of terminal costs, to have achieved a significant market penetration, discretionary services are purchased by all income levels despite their relatively high price compared to the cost of providing these services.

Communication usage varies widely among users. Early research here and abroad has identified significant differences in the telephone habits of men and women, by age, by marital and family status, by where they live, by ethnicity, and by other variables.[43] These studies indicate that many urban blacks find call-waiting and three-way calling extremely valuable for maintaining community help linkages, and, further, that call-waiting can be used as a party line or second line in a multi-family dwelling at a cost of less than a quarter of the subsidized cost of the monthly rate for unlimited local calling and about half the subsidized cost of the lowest available monthly rate. Telephone apprehension may strike low-income families, especially when they fear for their safety, and call-blocking or caller-identification may also be perceived as a necessity.

This suggests a policy that recognizes the need for certain basic telephone services that go beyond the dial tone, that include some discretionary services that have been shown to be especially valuable to low-income families and individuals who are recipients of universal service support. Telephone assistance is a form of welfare and should be provided to qualified recipients "with no strings attached" so they can use their payments to purchase the package of services they believe is most valuable to them.

There are many consumer network information services, or consumer videotex services, permitting users to conduct transactions, send and receive electronic messages, and access a wide range of information services. Between 22 percent and 26 percent of households in the United States are estimated to have personal computers. Of these households, about 16 percent have the necessary hardware and software for accessing information sources and for sending computer mail or electronic messages. Users must subscribe to the service, maintain a

mailbox for receiving mail, be assigned a password to access the information source, and pay a monthly fee in addition to the cost of some of the information not offered without charge.[44] Unlike the French Minitel system, which is often seen as a model of a nationwide information network service, users cannot easily move between different networks, consequently it is difficult to send messages to parties that are not also subscribers to the same system.[45] Between 1987 and 1988 subscribership to these services grew by about 24 percent. At the end of 1990 there were about 2.5 million subscribers to all of the consumer network information services.

Critical to providing access to network information services is the cost of the terminal. If the recent decision by the court overseeing the AT&T divestiture survives what are likely to long court tests, local operating companies will extend network intelligence to the terminal, leading to lower-cost information technology for the home and for business and significantly improving prospects for universal information services.[46]

The Need for an Information Safety Net. As with the aforementioned discretionary services, there may be important information services that should be available to all citizens regardless of their ability to pay. If public policy deems that access to information is as important as access to communications, the cost of terminals could be underwritten by an "Information Link-Up America" subsidy where necessary, paid as part of monthly rental of telephone services or in the cost of the information service package purchased. Determining just what information should be made available to everyone, an information safety net, is a most difficult task. What is critical information to one household may be perceived as information overload to another.

How universal service is to be defined will depend on the evolution of the multiple intelligent networks and the policies created to ensure interconnectivity and interoperability among them, for without these features, universal service, however defined, will be impossible to achieve. It will also depend on the services offered in the marketplace and their cost to the household and the small business. While major industries are very rapidly moving toward an information economy, and are benefiting greatly from the technologies available either by leasing from the operating companies or by designing and installing

them themselves, current regulatory provisions do not yet provide for the rapid dissemination of an information technology to small- and medium-sized business, those very activities that employ the largest number of workers and exhibit very rapid economic growth. Nor are the residential customers benefiting from technologies available to major telecommunications users.

PRINCIPALS FOR RE-DEFINING UNIVERSAL SERVICE

Telecommunications is a rapidly changing technology with dramatic developments appearing almost weekly. The telecommunications industry is among the most dynamic in the world. In every industrialized nation and in almost every newly emerging nation it is considered a necessary infrastructure for economic growth. Telecommunications is also seen as essential for membership in the social community, basic for the diffusion of knowledge and for freedom of expression and communication. For these reasons, the provision of universal service often overrides the questions of economic efficiency.

How universal service is defined depends not only on technology but on the nature of domestic and global markets and with the social uses of communications. In the past, general interconnectivity of the network that provided a single service, message voice communications, led to a definition of universal service that provided an audio dial tone in 93.3 percent of the nation's households and available to almost 95 percent of all households. Additionally, high-quality voice communications, single-party lines, touch-tone dialing, and an expectation of privacy are embodied in the definition of universal service.

Information has become the most valuable currency in modern societies; uncensored access to information and its transport are essential requirements for economic, social, and political growth. Nations are engaged in a highly competitive global market in which rapid and efficient access to information and its distribution are of great strategic value. No longer is the traditional public switched network the sole provider of telecommunications services. Multiple, private, public, and quasi-public affinity networks, using a mix of wired and non-wired technologies to deliver voice, data, video, and image information, are spreading throughout this nation and throughout many

of the developed countries of the world. For these reasons, it is necessary to redefine universal service. To do so, some principles must be agreed upon:

- The values that led to the goals set forth for universal service have not changed. It is more important than ever that uncensored access to information and the means for its distribution be as universally available as possible. Any means by which the marketplace of ideas is enhanced should be encouraged.

- Network interconnectivity and interoperability are necessary prerequisites for achieving universal information services. Many common carrier and quasi-common carrier networks will operate in a competitive environment and use novel technologies that could be incompatible with established standards. It may be uneconomical for these carriers to interconnect. If it is required by regulation, who is to bear the cost? A significant barrier to achieving this interconnectivity will be determining who is responsible for overseeing network standards and network interconnectivity.

- Universal information services will evolve as the market for new services grows. Competition could lead to costs that make information available to all users or could raise the costs and create an information underclass. If the market does not achieve this objective, what kind of government intervention is necessary for ensuring that there is no information underclass? Who is responsible for developing and implementing assistance plans for an information safety net?

- Specific information services as well as a basic package of discretionary services will emerge from experience in the marketplace. An alternative approach could be state-federal experimentation with various levels and mixes of information services, leading to a national consensus for a universal information service policy.

- Universal information services assistance should be viewed as a general welfare payment and it should be up to qualified recipients to allocate their payments. Individual information and communications needs are extremely diverse and only by allowing recipients

of aid to make choices will the marketplace of information be expanded for the benefit of democracy.

Whatever the appropriate policy for the provision of universal information services, it is likely there will be pressure on basic service rates, however basic service is defined, and that low-income households might very well find telephone and information services too expensive, unless subsidies are continued and evolve to take into account discretionary and information services and other enhancements that are found to be in the public interest. The conflict requiring resolution is between the regulatory policies of the past and those which many associate with the future: preserving universal service in the expanding arena of telecommunications and information services in a competitive marketplace. How to provide information and other services must be considered on an inventive as well as a pragmatic level, because there is every indication that what falls into the category of today's plain old telephone services versus tomorrow's information services is undergoing fundamental change in an information age. As more and more social and commercial services rely on telecommunications to substitute for interpersonal communications the basic notion of universal service, the essential contribution of telephone access to effective participation in society must be kept clearly defined. In the year 2020, it may be that some of today's enhanced services will be considered basic. If the most common way for the general public to interact with banks, the division of motor vehicles, city hall, and other business or government organizations, is via computerized interactions using telephone lines, then plain old telephone service must be redefined to include technologies necessary to such interactions, rather than face a situation where access to and efficiency of services is entirely determined by income.

I wish to thank Larry Povitch at the FCC for his guidance and assistance, not only in the preparation of this essay, but in my previous work from which much of this was drawn. Any errors of fact or interpretation are solely my responsibility.

ENDNOTES

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2. De Sola Pool, Ithiel, *The Social Impact of the Telephone*. Cambridge, MA: MIT Press, 1977, pp. 156–157.
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10. The Communications Act of 1934, Public Law 416, 73rd Congress, June 19, 1934, Title I, General Provisions, Sec. 1.
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15. Jacobson, Robert, *An Open Approach to Information Policy Making: A Case Study of the Moore Universal Telephone Service Act*. Norwood, NJ: Ablex Publishing Corp., 1989, pp. 148–149.
16. Monitoring Report, CC Docket No. 87-339, January 1991, prepared by the staff of the Federal-State Joint Board in CC Docket No. 80-286, pp. 68 and 70.
17. New York Public Service Commission, "Opinion and Order: Regulatory Response to Competition," Opinion 89-12, Case 29469, May 16, 1989.
18. California Public Service Commission, "Staff Report: Alternative Regulatory Framework for Local Exchange Carriers, Phase I," Docket 8711033, January 11, 1988.
19. Idaho Public Service Commission, "Order: Investigation of a Need for an Idaho Universal Telephone Fund," Case U-1500-174, Order 21788, February 29, 1988.
20. National Consumer Law Center, "Michigan Bell Telephone Company: Deregulation, Cost Allocations, Rate Design, Universal Service," October 1990.

21. The specific question asked in the Current Population Survey from which this data is obtained was, "Is there a telephone in this house/apartment?" If the answer to this question was "no," the question was asked, "Is there a telephone elsewhere on which people in this household can be called?"
22. Monitoring Report, CC Docket No. 87-339, January 1991. Prepared by the staff of the Federal-State Joint Board in CC Docket No. 80-286, p. 13.
23. Basic Exchange Telecommunications Radio System (BETRS) is an FCC classification for digital microwave radio systems which have greater capacity and are more secure than analog radio.
24. The Supreme Court upheld the Louisiana Public Service Commission in *Louisiana Public Service Commission v. Federal Communications Commission* (476 US 355, 1989) denying the power of the federal government to override the state in the matter concerning depreciation rates for common carriers.
25. Bowie, Nolan, "Equity and Access to Information Technology," *The Annual Review, 1990*. Nashville, TN, and Queenstown, MD: The Institute for Information Studies and The Aspen Institute, 1990, p. 143.
26. The Michigan study referred to in Endnote 20 states that 83 percent of respondents without telephones say that cost is the reason for not having a telephone. Additionally, cultural and religious objections to the telephone as among the Amish (see, for example, Diane Zimmerman Umble, "The Telephone Comes to the Pennsylvania Amish Country: A Study of Resistance to Technology at the Turn of the Century," paper presented at the 39th Annual International Communications Association, May 1989), or fear of the telephone (see, for example, Robert LaRose and Jennifer Mettler, "Social and Antisocial Uses of the Telephone: An Exploration of Social Learning Explanations of Personal Telephone Behavior," presented at the 39th Annual International Communications Association, May 1989) are factors discouraging the use of the telephone.
27. Networks may be interconnected but if the rules of the road or protocols by which they operate do not provide for the exchange of information, that is, they are not interoperable, interconnection is of little value.
28. The U.S. District Court, which has been monitoring the Modified Final Judgment agreed to by AT&T to settle the government anti-trust suit in 1984, prohibited the regional Bell operating companies from providing information services. This restriction was lifted on July 25, 1991.
29. For example, low-income families headed by women report that they use three-way calling as a security measure during the night.
30. Monitoring Report, CC Docket No. 87-39, staff of the Federal-State Joint Board in CC Docket No. 88-286, March 1989, pp. 86–89.
31. There is some evidence that low-income subscribers, when faced with an increase in their flat-rate charges, would switch to measured service in order to maintain their telephones for emergency and other important uses. While heavy users would pay more under measured service, they are also the ones who are least likely to disconnect in the face of a rate increase.
32. The United States Constitution, Article I, Sec. 8, Par. 7.
33. De Tocqueville, Alexis, "On the Uses Which the Americans Make of Public Associations in Civil Life," *Democracy in America*. New York: New American Library, 1956, pp. 198–202.

34. *Ibid*, p. 199.
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36. Ellul, Jacques, "Preconceived Ideas About Mediated Information," *The Media Revolution in America and Western Europe*, E.M. Rogers and F. Balle, eds. Norwood, NJ: Ablex Publishing Corp., 1985, pp. 95–107.
37. "The Changing Urban Neighborhood: From Neighborhood to Neigh-Dwells—A Sociological Study," USC Social Science Series, No. 1. Los Angeles, 1927.
38. See, for example, "Networks as Personal Communities" by Barry Wellman, Peter J. Carrington, and Alan Hall in *Social Structures: A Network Approach*, edited by Wellman and S.D. Berkowitz. Cambridge, MA: Cambridge University Press, 1988, pp. 130–184; and "The Strength of Weak Ties: A Network Theory Revisited," by Mark Granovetter in *Social Structure and Network Analysis*, edited by Peter Marsden and Nan Lin. Beverly Hills, CA: Sage Publications, 1982, pp. 105–130.
39. We refer to the large number of audiotex services available, for an often considerable charge, via the proliferating 900 services.
40. National Telecommunications and Information Administration, U.S. Department of Commerce, *Telecom 2000: Charting the Course for a New Century*. Washington, DC: U.S. Department of Commerce, October, 1988, p. 238.
41. *Ibid*, p. 313.
42. Comparisons are often made with the French Teletel network and their Minitel services. The Teletel network provides network intelligence to the home. Consequently, Minitel is a telephone-based system suitable for a very low-cost terminal which, if not provided free in place of a printed directory, would sell for about $75. The U.S. telecommunications network requires a computer-based system to access information with the concomitant higher-cost, even if more versatile, computer, which with communicating capability costs in the neighborhood of $1,000. The French Network provider, the DGT, provides network intelligence to the Minitel or telephone while the MFJ has constrained such software provisions of intelligence to the telephone in the United States.
43. For example, Ann Moyal in "Women and the Telephone in Australia: A Study of National Culture," and Gerard Claisse and Franz Rowe, "Telephone Facts and Myths: A Study of the Social Uses of the Telephone in France," both in *Soziologie des Telefons*, edited by Axel Zerdick and Ulrich Lange. Berlin: Freie Universitat Berlin, 1985; Lena Rakow, "Gender, Communication, and the Technology: A Case Study of Women and the Telephone," Ph.D dissertation. University of Illinois at Urbana-Champagne, 1987; and Herbert S. Dordick, "The Social Uses of the Telephone" in *InterMedia*. London: International Institute of Communications, Vol. 11, No. 3, 1983.
44. Prodigy, the Sears-IBM service, charges only a monthly fee.
45. See Endnote 27.
46. How well the marketplace of information will be served will depend on the degree to which the regional Bell operating companies make their network available to independent information providers. For this reason many observers argue that the operating companies should be information common carriers or be constrained to offer a limited number of their own information services.

THE GLOBALIZATION OF UNIVERSAL TELECOMMUNICATIONS SERVICES

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SECTION 1
INTRODUCTION

The Broad Context

It seems almost trite in our sophisticated world to note the explosive growth of information. We know that global population is expanding. We sense the rate of technological innovation is growing at a much higher rate than our population. We are certainly painfully aware that information overload is a problem in at least the Organization for Economic Cooperation and Development (OECD) countries. Despite this general awareness, many well-informed people are unaware that information is expanding at a rate that is at least 200,000 times faster than that of human population. This is not analogous to someone running to catch a racing car. Rather, it is more like a snail trying to catch a spaceship, should it ever occur to a snail that this was a worthwhile objective. The world population has increased 50 times since 500 B.C., from 100 million to 5.2 billion people. The global information base, in contrast, has gone from about 10^8 bits (or some 10,000 pages of information) to 10^{15} bits (or some 100 billion pages). By the end of the 21st century, if exponential growth continues, we could even reach 10^{24} bits, or the equivalent of 100 quintillion pages of information, or about 30 million Libraries of Congress. The concept of a Renaissance man or woman is rendered obsolete in such a staggering new information environment.

This new information environment implies many other things as well. Who will not need intellectual prosthetics to store, retrieve, and even analyze information in this new world? Education and health services will be increasingly provided by electronic means. Privacy will be harder to protect. Trade will be more global and more dependent upon accurate and up-to-date information. Information workers will telecommute to work across town, across country, and across continent. "Electronic immigrants" will travel to work electronically, perhaps halfway across the world. The fact is, the world of tomorrow will be in many ways fundamentally different than the past. Moses could live more comfortably in the world of Thomas Jefferson than, say, Theodore Roosevelt could live in early 21st-century America.

The rate of change is speeding up in an amazing way. If we pretend that the time elapsed since the Southern ape man appeared on planet Earth some five million years ago and today has been a single supermonth, where every second represents two years, the "future compression" problem comes into clearer focus.

In our supermonth, humankind spends almost the entire 30 days as a hunter/gatherer. It is only in the last one-and-a-half hours of the supermonth that towns and agriculture have arisen. The last four minutes are the Renaissance, and the last 90-second segment represents the Industrial Revolution. Amazingly, it is only the last 15 seconds that relates to transistors, satellites, fiber optics, electronic switches, color television, biotechnology, and artificial intelligence. In physics, when acceleration accelerates, it is called *jerk*. In our modern information age, the time differential of change is speeding up and "jerking" us into the future. This document's perspective thus contemplates the future of telecommunications and information services in a broad context. Although parts may be somewhat technical in scope, the ultimate purpose of this article is to examine the social uses of telecommunications in the 21st century. We will also explore how the United States relates to the rest of the world in this respect. If everyone or virtually everyone in the United States were to have relatively free and open access to a range of modern electronic services in the decades just ahead, it would seem a wonderful breakthrough. Yet if at the same time most of the world were to lack this capability, what are the implications? Can such a basic disparity be long sustained? This is far from a new issue. It is, however, highlighted and made more urgent by the fact that now it is technically

and economically possible to address such issues. Further, the economic stakes in terms of jobs, education, health, and even world peace are much higher. As we move systematically to a true global economy, the problem of universal global telecommunications services will come to us—even if we do not come to it.

We are not talking about a modest proposition here. Telepower in its various forms—telecommunications, electronic entertainment, computer and information services, robotics, artificial intelligence, and expert systems—is already reshaping the global economy, internationalizing labor, and shifting jobs in space, time, and concept. Some would argue it is rendering the national state obsolete. The idea of a universal and globally pervasive telecommunications system (i.e., one that is digital, affordable, and user responsive) is not only powerful in its implications but raises at least three fundamental questions: Can it be done? Should it be done? and How can it be reasonably accomplished? To explore these issues we must first have a better understanding of today's world and how much it has changed in even the last decade.

The World of Telecommunications Today

No one can reasonably argue with the proposition that a global economy is rapidly evolving on our planet and that global corporations are the primary change agent. Ford cars now sold in the United States have more foreign parts and "content" than not. Meanwhile, Honda, Toyota, and Mazda are manufacturing cars in places like Ohio and Kentucky and Tennessee. American Airlines shifted its computerized inventory control operations from Tulsa, Oklahoma, to Barbados. Japanese, U.S., and European software development is often done offshore. US West even went so far as to bring a "virtual colony" from India to the United States to cope with its expanding software development needs. The good news is that reasonably priced telecommunications can be brought to rural America today. The bad news is that in a global economy telecommunications may be brought anywhere else too. Professor Robert Reich of the Kennedy School of Government at Harvard has stated that everything we thought we knew about economics and national industrial policies is "wrong" and needs to be "totally rethought." Reich suggests that a basic shift has not really been fully appreciated: "As almost every factor of production—money, technology, factories, and equipment—moves effortlessly across borders, the

very idea of an American economy is becoming meaningless, as are the notions of American corporations, American capital, American products, and American technology."[1]

As the world continues to shrink through global trading, "electronic immigrants," and a global labor pool, the disparity between the world's haves and have-nots increases. This is a bigger problem than is sometimes realized. Estimates of the number of people competing in the global labor pool run as high as 85 percent of all workers. (The exceptions are largely restricted to government workers, local service workers like teachers and health workers, and subsistence farmers.) Increasingly we find that almost every manufacturing and service job can be shifted across town, across the country, or across the world. Robots, expert systems, artificial intelligence, computer services, and telecommunications will change the equation even more. Today's technology and economics are pulling us toward a uniform and universal labor market. Any country which does not proceed in this direction is likely to be less competitive and to experience economic setbacks.

Professor Reich has suggested that as a result of these changes the national economy does not really exist. Instead he suggests it is as if certain sectors of the economy are on different boats, with some faring much better than others. Those in the boats marked "High Technology," "Innovation," "Value-added Services," etc., are rising on the sea of the global economy but those in boats marked "Manufacturing," "Repetitive Functions," "Routine Services," etc., are less buoyant or even sinking. Thus Professor Reich argues that electronic technologies and global economic processes are both creating a new world and determining new winners and losers.[2]

In my book *Future Talk* the case was made much differently, but the basic conclusion was the same. Those who obtain telepower in its various forms and use it effectively, especially on a global scale, will succeed in the 21st century. The uses of this powerful technology can be good, bad, or neutral but the effects are, in time, likely to be pervasive, global, and ultimately universal.[3]

Few people appreciate how much the world of global communications has already changed in just the last 25 years. International communications have gone from well under 1,000 voice circuits to nearly 300,000. International color television channels have gone from none to many hundreds. A single advanced satellite like the INTELSAT

VI or an advanced fiber optic cable like TAT-9 can send billions of bits of information across an ocean in a single second. That is sufficient capability to send the entire *Encyclopedia Britannica* with all its illustrations every three seconds, or to send every episode of *Dallas* and *Dynasty* ever produced all at once. Fortunately Europe or Japan is much too clever to consider seeking such an electronic blitz.

The point is, the capability is there and is growing—not just between the United States and developed countries, but in all the links to the entire world. The latest in digital interconnection is available everywhere. Some 175 countries and entities are now linked to the INTELSAT global satellite system. The U.S.S.R., the last major telecommunications user in the world not to belong to this global cooperative, joined in July 1991. In short, the worlds of nations and large corporations are webbed together in amazingly sophisticated ways that allow instantaneous worldwide trading almost everywhere on our planet.

Ironically there is a grand symmetry in that it is the rural and remote locations of the world which are not "plugged in." This is true regardless of whether it is Alaska or Appalachia in the United States, Sinkiang in China, Amazonia in Brazil, or Ecuador, the jungles of Zaire, or the far northwest of Canada. The combined or averaged national growth rates of national telephone systems tell us virtually nothing about universal service or how Robert Reich's "economic boats" are rising and falling. The first step is to recognize that, on balance, the move toward globally available universal telecommunications services should be encouraged based upon their generally beneficial impacts. Certainly the broad availability of telecommunications is likely to continue to accelerate based upon the specific examples below of what is already happening today. In a later section we will explore the whys and hows of this transformation when we examine a model of the global telecommunications environment and how it may evolve over the next two decades. But let us begin with current realities.

Education. A recent UN study concluded that in the next 30 years there will be more people to be educated than in all of the history of humankind up to this point. By that time, world population may be closing in on eight billion and may not peak until the end of the 21st century, perhaps at 12 billion or more. In China, a National Television University was created under Project Share in 1985 with some 57 earth

stations and a few thousand students. Today that system has grown to 30,000 earth stations and three million students and teachers who use the system daily. Plans to expand to 10 million students and teachers are being actively pursued. It is conceivable that within decades "tele-education" will become the conventional mode of education and that the availability of the high-quality electronic modes of education will be demanded as a "universal right." When this will happen will depend on many factors and may come much later to parts of, say, Africa and South America, than to other parts of the world. The point is that over the next 20 to 30 years basic shifts in thinking will occur as to what are basic and universally needed services.[4]

Health. Electronic health services, training, and diagnostic testing are now routinely provided over a telephone line between the Memorial University Hospital of Nova Scotia and both the Caribbean and East Africa. In fact, because of the time zone differences, the same satellite capacity is used for both functions but at different times of day. In a much different application a single video conference on AIDS involving the world's leading researchers was shared with more than 30,000 doctors and health workers in North and South America, Europe, and Africa. It is hard to believe that expansion of these health and medical services to provide universal access is not a desirable goal.[5]

Global News. Today virtually every world leader knows the latest developments in global news almost as they happen. It is not because they have better staffs or are better educated. No, it is because CNN has given a satellite receiver to more than 100 heads of states and presidents. Skynews, Visnews, and various national networks are trying to follow suit. Today CNN has a global data base of information and contacts which allows it to uplink news information from almost anywhere to anywhere in a matter of minutes or at the least hours. In such an envi-ronment, political repression, human rights violations, and even war are increasingly difficult to get away with without having world opinion weighing heavily in against the "bad guys." The thawing of the Cold War and the destruction of the Berlin Wall are in some ways the results of instantaneous electronic news. In 20 years even Third World dictatorships, censorship, and rights violations will be made difficult to sustain.[6]

Electronic Funds Transfer. It is estimated that the total amount of electronic funds transfer now taking place exceeds a trillion dollars a day, or nearly $400 trillion a year. Given the fact that the entire global economy is about $24 trillion a year, these electronic exchanges are a staggering figure. This may be the single most significant statistic underscoring just how interlinked and integrated our global economy is. Electronic funds transfer systems like the Society for Worldwide Interbank Financial Transactions penetrate everywhere; they existed even in Yugoslavia and Hungary 10 years ago. Specialized networks on a global scale now routinely support electronic funds transfer, airline reservations, global news, commodity trading, and dozens of other functions. When these "private networks" bypass the less developed countries and exclude rural and remote regions, there is real potential for economic harm and loss.[7]

The Basic Premises

There is a need to think in terms of totalities. Even private and proprietary systems will need to observe some key standards in order to interface with the "big electronic telecommunications machine." Ongoing world trade and the huge network efficiencies that the coming universal global digital information networks can provide will undoubtedly create pressures to move toward "open" international world networks. Yet national, political, and economic interests plus competitive corporate objectives will serve to splinter electronic networks and integration. The basic premises of this paper are thus twofold:

Premise One: Global trade, especially in information services, will create powerful new economic forces for interconnected and open universal global telecommunications and computer networks.

Premise Two: The creation of these networks in response to service demand will not be easily or quickly accomplished. This is due to the many incentives to move toward making multiple "standards," the individual interests of equipment manufacturers and vendors, localized market goals, and even competitive and deregulatory policies of individual governments that can work against universal or global objectives.

This is not to say anyone is particularly opposed to a universal information system which is low-cost, digital, efficient, and reliable. It

is that few entities other than perhaps the International Telecommunications Union (ITU), with its long-term effort to create integrated services digital network (ISDN) and broadband ISDN standards, are attempting to achieve this overall result as their *prime* objective. Unfortunately the ITU's efforts are often handicapped by political, economic, social, cultural, and technological rivalries. Some even believe that the ITU has become obsolete in today's fast-changing world.

The Overall Telecommunications Environment

The overall telecommunications environment that serves as the backdrop for this study includes the following aspects: (a) rapid technical, operational, and even social innovation; (b) explosive growth of information services; (c) rapid digitization of all information, especially that for international or national interchange; (d) growing volume of international trade; (e) decreasing prices in information services amid increased competition; and (f) a tendency for telecommunications and computer standards to diversify rather than move toward consensus.

SECTION 2
GLOBAL MODEL FOR THE TELECOMMUNICATIONS ENVIRONMENT

To understand how the process of global change in telecommunications will take place requires a fair degree of sophistication. Forces of change, innovation, and inertia exist at many levels within key commercial institutions, standards-making bodies, technological innovators, economic interests, political bodies, and trading units. The complexity is such that a model to reflect the various interactions and competing interests has been created to help represent how the process works.[8]

The following key elements of a global development model for digital telecommunications are constantly interacting and influencing each other: (a) applications and services (voice, data, imaging, and video); (b) transmission, switching, and signalling technology; (c) technical standards; (d) economic incentives; (e) government regulation; and (f) market characteristics and conditions.

Although there are a multitude of ways these factors can be combined and analyzed (and certainly there are additional factors that

could make this model even more complex), the approach depicted in Figure 1 can provide good insight into the "anticipated future of telecommunications." This model illustrates the big picture. It seeks to show how the process of globalizing the world's telecommunications system could work and what enormous potential this process could hold if universal service could be achieved. It would make the world fundamentally different.

This same model can also help us see why universal service will remain extremely difficult to achieve for some time at the national and international levels. Let us examine the component parts of our global telecommunications model.

Applications and Services

Applications and services will perhaps be the primary factors in designing telecommunications networks of the 21st century. Attachment 1 documents the anticipated services, applications and features for digital telecommunications in the 21st century. Analyzing these future requirements, it is possible to isolate key performance-related elements that will need to be considered in virtually every instance. Simple objectives, such as to provide everyone on planet Earth with a "telephone," are appealing but also over time essentially self-defeating. The goals must change and adapt as more and different technologies and telecommunications services become available. It is the right to communicate rather than a cellular telephone or a medium-speed modem that should constitute the goals for the 21st century. Thus it is essential to monitor the *relative* state of global telecommunications services as well as absolute numbers.

It is important to monitor telecommunications performance factors in precise and clear ways in building our model for global electronic systems. Although these should be carefully conceived and defined in a technical sense, a detailed understanding of each precise technical component is not essential.

The key service and technology related issues are those that deal with regulatory policy and standards concerns. Of these the following are perhaps the most important:

- Do we continue to maintain seamless interconnection between analog and digital systems? (For example, how do you link to rural,

Figure 1 Functional Model of the Global Telecommunications Environment

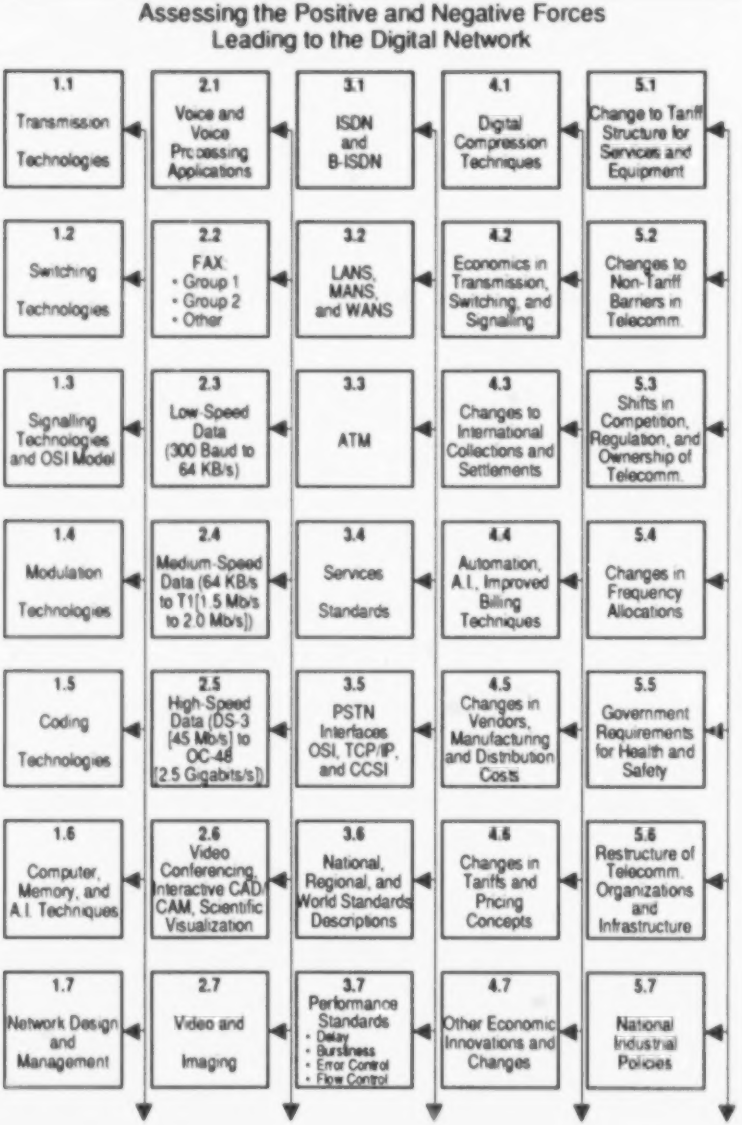
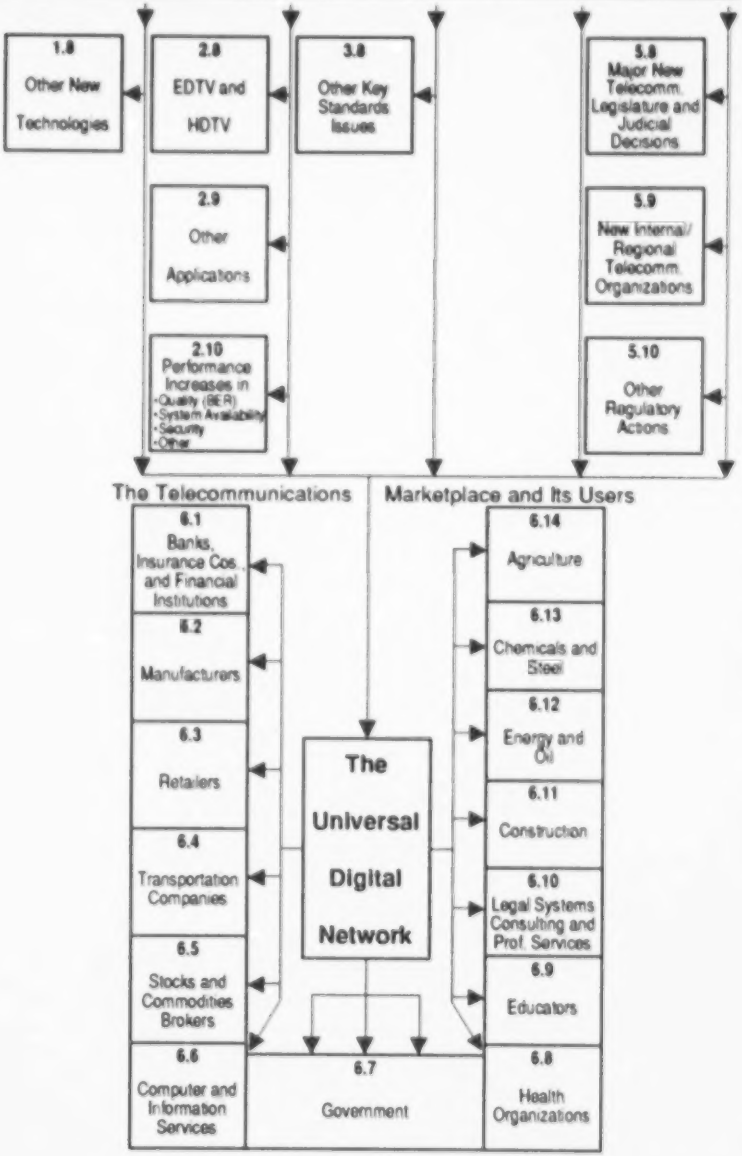

Assessing the Positive and Negative Forces
Leading to the Digital Network
1.1 Transmission Technologies
2.1 Voice and Voice Processing Applications
3.1 ISDN and B-ISDN
4.1 Digital Compression Techniques
5.1 Change to Tariff Structure for Services and Equipment
1.2 Switching Technologies
2.2 FAX • Group 1 • Group 2 • Other
3.2 LANS, MANS, and WANS
4.2 Economics in Transmission, Switching, and Signalling
5.2 Changes to Non-Tariff Barriers in Telecomm.
1.3 Signalling Technologies and OSI Model
2.3 Low-Speed Data (300 Baud to 64 KB/s)
3.3 ATM
4.3 Changes to International Collections and Settlements
5.3 Shifts in Competition, Regulation, and Ownership of Telecomm.
1.4 Modulation Technologies
2.4 Medium-Speed Data (64 KB/s to T1[1.5 Mb/s to 2.0 Mb/s])
3.4 Services Standards
4.4 Automation, A.I., Improved Billing Techniques
5.4 Changes in Frequency Allocations
1.5 Coding Technologies
2.5 High-Speed Data (DS-3 [45 Mb/s] to OC-48 [2.5 Gigabits/s])
3.5 PSTN Interfaces OSI, TCP/IP, and CCSI
4.5 Changes in Vendors, Manufacturing and Distribution Costs
5.5 Government Requirements for Health and Safety
1.6 Computer, Memory, and A.I. Techniques
2.6 Video Conferencing, Interactive CAD/CAM, Scientific Visualization
3.6 National, Regional, and World Standards Descriptions
4.6 Changes in Tariffs and Pricing Concepts
5.6 Restructure of Telecomm. Organizations and Infrastructure
1.7 Network Design and Management
2.7 Video and Imaging
3.7 Performance Standards • Delay • Burstiness • Error Control • Flow Control
4.7 Other Economic Innovations and Changes
5.7 National Industrial Policies

Figure 1 Continued



remote, and Third World countries across analog-to-digital or satellite-to-fiber interfaces?)

- Do we go to telecommunications superhighways designed for the electronic and opto-electronic equivalent of everything from motorscooters to 18-wheel semi-trailers? Or do we optimize for various services?

- Do private networks and public switched telecommunications needs grow together or apart, and how do new digital services affect this trend?

All of these issues will have a great impact on future applications and services. They must be addressed in implementing our detailed telecommunications model.

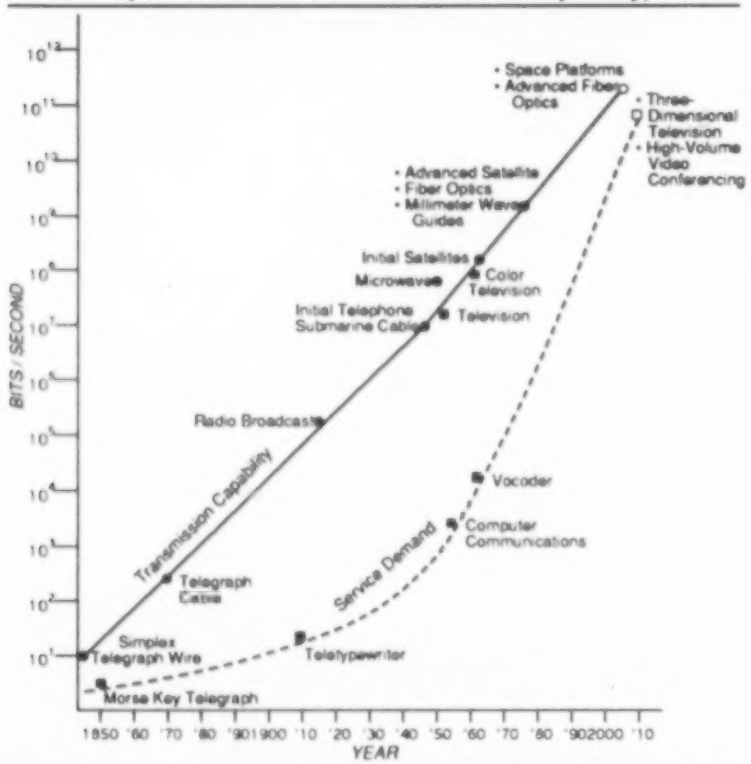
Transmission, Switching, and Signalling

The rapid developments in transmission, switching, and signalling have been phenomenal. Figure 2 shows how transmission systems have grown exponentially for the last 150 years in close concert with the growth of services and their expanded throughput requirements. Switching capabilities have also zoomed ahead, especially since the 1960s with the advent of stored program electronic switches, which have boosted performance at an ever-accelerating rate over the last three decades (see Figure 3).

Last but not least has been the rapid development of telecommunications protocols and expanded signalling capabilities to add intelligence to the network. Signalling channel speed in the past five years has increased from 1,200 bits per second to 64,000 bits per second. The power of signalling networks to provide automatic number identification, to call up remote data bases cued to the incoming number, to forward calls, and to perform a host of other intelligent functions is almost miraculous. Policy concerns about privacy, surveillance, and security, however, may prevent application of some of the new features.

In sum, new developments in transmission, switching, and signalling should produce dramatic gains in telecommunications. They should improve service options, enhance throughput, increase reliability and quality, and lower cost. Even so, the use of this technology is

Figure 2 150-Year Look at Development of Telecommunications (Service Demand vs. Transmission Capability)



not entirely straightforward. The cost of replacing older technology is high. Fiber-to-the-home is a clearly desirable goal, but fiber-to-the-curbside pedestal is many times less expensive and can be accomplished much more quickly. Furthermore, until an optical-to-optical interface can be achieved with home TV sets and computers, the question, Why bring fiber into the home? still remains. Figure 4 shows an early versus a later implementation profile for fiber-to-the-home, with the more conservative projection seemingly the most realistic.

Satellites are alive and well despite the rapid advances of fiber optic cable. As can be seen in Figure 5, satellites will provide for some time rather dramatic economies of service. At least for a while,

Figure 3 Switches

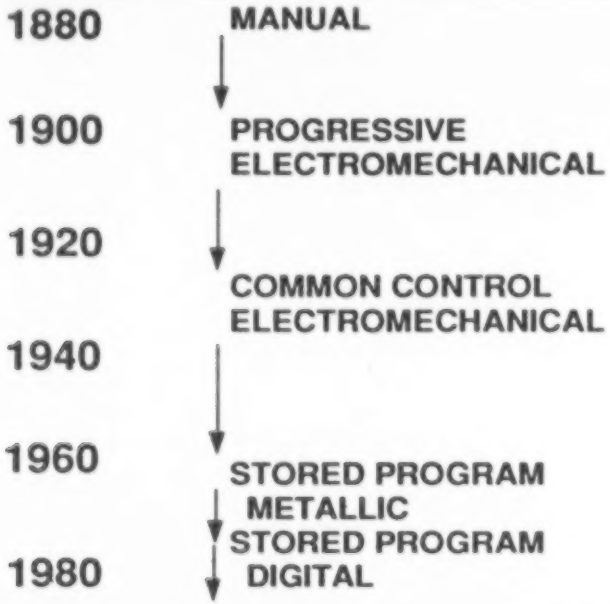
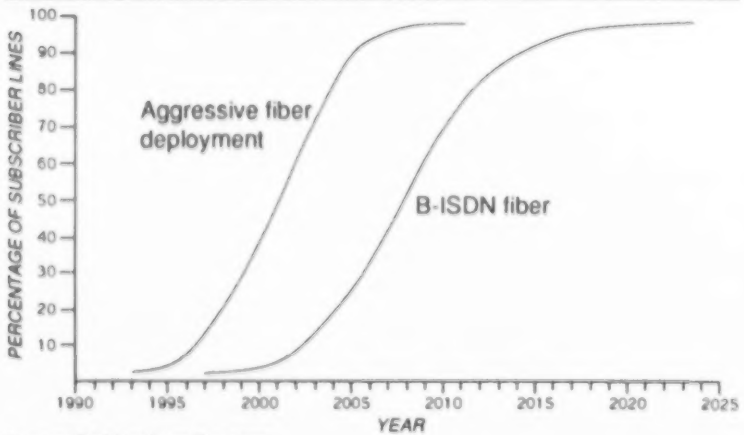
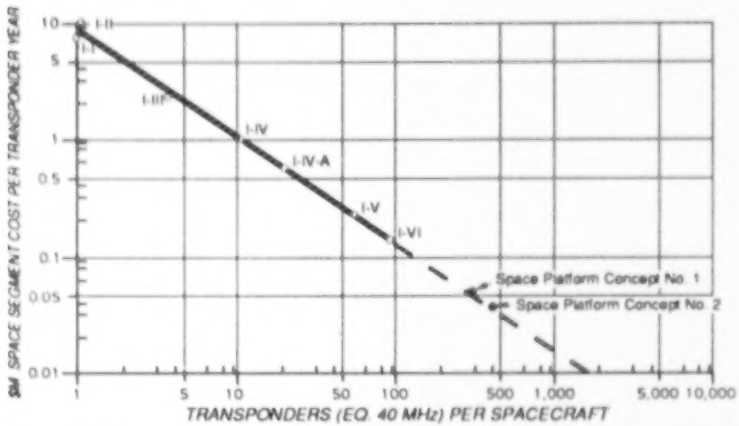


Figure 4 Fiber to the Subscriber



Source: Bell Northern Research

Figure 5 Intelsat Series Demonstrates Economy of Scale in Communications Spacecraft (Past and Present)



satellites will remain the leader in mobile, broadcasting, and international services. With cellular radio, personal communications networks (PCNs), wireless local area networks (LANs), direct broadcast satellites (DBS), and several other options in the wings, it is simply wrong to see the world of the future as being exclusively inhabited by fiber optic cables. Plugging a fiber into a plane, a train, or a boat is still a big technical problem. In thinking about this part of the universal global information network it is important to keep your eye on the money. This most sophisticated and highest-technology element of telecommunications networks makes up less than 10 percent of the overall investment. What is true, however, is that fiber optic cable will be the media of choice for high-density routes among developed countries, while satellites will frequently be the media of last resort for interconnection of rural and remote areas and for developing countries for at least several decades into the future. Regardless of the fiber-versus-satellite debate, transmission media command only a small share of total network costs.

Ninety percent of the world's investment in telecommunications is in the terminal equipment in the home and office, the switches, and the last-mile loops that connect networks to end users. It is here that

massive investments of perhaps trillions of dollars will be needed over the next 30 years as the global universal telecommunications network begins to take shape.

The future in the area of transmission, switching, and signalling is quite bright and the rapid development of new digital technology will likely be a major stimulant to the creation of the new "electronic machine" that will link the world together. Breakthroughs in fiber seem likely to be driven by soliton pulse technology that will allow ultra-high-capacity fiber optic cables without repeaters. On the satellite front there are several new frontier technologies that include on-board processing, new forms of multibeam antennas, and new low-orbit systems that use intersatellite links. In the more distant future we may see new hyper-light satellites stabilized by ground-based energy systems to create low-orbit geosynchronous systems. Microcell and picocell terrestrial radio systems and new infrared mobile systems all promise 21st-century transmission systems that are perhaps 1,000 times better in performance than those of contemporary systems. Today's transmission systems peak at about one billion bits per second (1 gigabit/second). In another quarter of a century these are likely to be terabit-per-second systems that could send the equivalent of the entire Library of Congress in less than 10 seconds.

Switching technology seems likely to remain the "bottleneck" in communications systems. As we move from electronic to opto-electronic and perhaps to completely optical switching systems, there are several critical junctions to cross. These will involve such fundamental issues as whether new types of algorithms driven by time-slot interchange will change the nature, function, and even purpose of switching systems. Likewise there may be opportunity, in bringing fiber to the home and to the small business, to completely redesign transmission and switching systems. They may offer lower cost and faster switching for outside plant connections than using highly centralized switching facilities at only a few locations. They also may expand provision for redundancy and system availability. In the new world of telecommunications, transmission and switching capabilities may become much more interchangeable. In a sense, telecommunications planning may become Zen-like in that parts of the systems, particularly processors, may assume many different roles rather than having only one function or one reason for existence.

Signalling and the "intelligent network" will increasingly define the roles that the various parts of the global electronic machine are to play. Signalling, the unifying element in the triad represented by transmission, switching, and signalling, is the vanguard of the future. In the past signalling was often considered to be a subset of switching, but in the future, intelligence in the form of expert systems and artificial intelligence will be added to the global network's telecommunications function in a number of ways. Further, as transmission-related processing begins to merge with network signalling and other intelligent network functions, the picture will likely become even more confused. On the transmission side we will see more signal processing, more digital compression techniques, more digital echo cancellation, more advanced concepts in error control, more digital flow control, and other similar processing techniques.

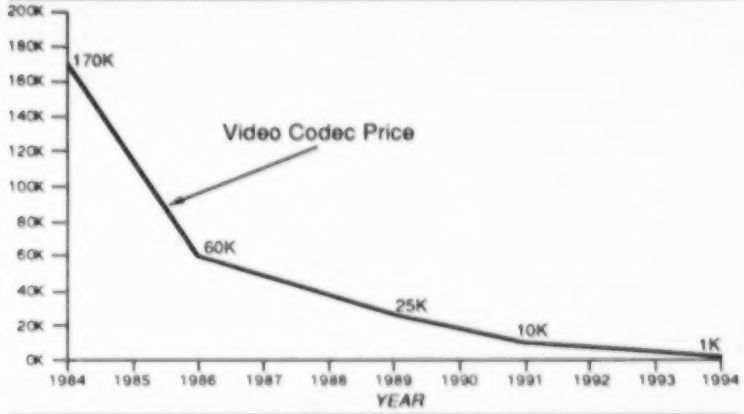
Equally important will be the application of advanced processing techniques to network intelligence, routing, and enhanced network features such as automatic number identification, automatic redialing, and X-window access to multiple data bases for scientific visualization and modelling. It is not surprising with these parallel uses of processing that we are increasingly driven to use the term *information technology* to refer to the combined use of telecommunications technology and computer science to create tomorrow's digital networks. This area, as can be seen in Figure 6, is producing the most dramatic gains in digital communications. Looking to the future it seems likely that we will employ ever-higher performance signalling channels. Clearly the open systems integration (OSI) seven-layer model is the most important concept in signalling to emerge in recent years. The questions is, How far will it evolve in future decades and, in particular, how far can the intelligent network, expert systems, artificial intelligence, machine interpretation, and other innovations take us by the early 21st century?[9]

Technical Standards

The world of technical standards has changed dramatically in the last 30 years. A world that was once rather unified, coherent, and predictable has become none of these things. What has changed? Practically everything. Critical changes have surfaced everywhere.

The number of developing countries since the late 1950s has risen exponentially, from a handful to well over 100. The political influence

Figure 6 Trends in Digital Processing and Compression



of these developing countries in the world's standards organizations, particularly the International Telecommunications Union, has gone from nil to substantial. The complexity of telecommunications systems and the number of standards have also skyrocketed. In 1980 there were about 1,800 technical standards approved by the ITU. Today there are close to 10,000 in force! As the pace of technical development has accelerated and competing interests in standards making have multiplied, the tendency has been for the overall process to slow down. While some claim that the ITU has become overly bureaucratic and inefficient, the real culprit is probably the torrent of technological change. The other dimension of the standards-making environment is the rather alarming growth of such organizations at the international, regional, and national levels.

There is the International Standards Organization (ISO), the key architect of the OSI model that is the main basis for interconnection of today's advanced digital systems. There is also the International Electro-Technical Commission (IEC), reflecting the standards-making interests of manufacturers and vendors of electronic equipment. The regional standards organizations are even more prolific.

The last few years have seen the creation of the European Technical Standards Institute, which joins the previously existing Council on European Posts and Telecommunications (CEPT), the Asia Pacific Telecommunity, the Committee on Telecommunications (CITEL) of

the Organization of American States (OAS), plus a growing number of national technical standards committees in the United States, Japan, and other countries. These organizations only seem to grow in number. In the United States, for instance, there is the American National Standards Institute (ANSI), the Accredited Standards Committee (ASC), the Computer and Business Equipment Manufacturers Association (CBEMA), the Exchange Carriers Standards Organization (ECSA), the Electronic Industries Association (EIA), the National Institute of Standards and Technology (NIST), and more.

This overabundance of standards-making organizations leads to real questions about the future. There is growing concern about both national trade protection and competitive maneuvering by warring manufacturers and vendors. There are also splits between developed and developing countries, not to mention honest disparities of opinion about highly complex technical standards issues. These factors combine to make it almost impossible to come up with "good" standards.

There are thus several results possible. One common occurrence is that conflicting opinions simply deadlock and no agreement can be reached in a timely manner. ISDN, for instance, was first seriously discussed within the ITU framework beginning in 1973. The basic agreements on ISDN standards, the so-called I Laws, are now largely in place after nearly 20 years of debate. Most users, however, consider basic-rate ISDN at 144 kilobits per second to be totally inadequate and hopelessly slow in today's fast-moving world. In short, by the time the standards makers agreed, the standard was *passé*.

The other result is likely to be agreement to a host of different standards so that the resulting situation is much like there are no standards at all. The world of television standards is just one case in point. There are today dozens of television standards, including PAL, SECAM, NTSC, B-MAC, C-MAC, D-MAC, D2-MAC and so on. (It is not important to know what all these acronyms stand for, but simply that an enormous complexity of TV standards exists. One hint, however, is that the North American standard NTSC does not stand for Never Twice the Same Color, its critics notwithstanding.)

The high-definition television (HDTV) standards area seems to be headed for an even bigger morass. Here there are incipient standards based on 850-, 875-, 1,125-, and 1,250-line displays, at least two aspect ratios, and a multitude of other factors.

In any model of a universal global telecommunications network, technical standards must be an important part of the equation. The future course of standards, however, is unlikely to follow a consistent straight-line projection; based on conditions over the last two decades, it seems more likely to follow a random walk. The greatest likelihood is that computer-based protocols for interfacing will tend to resemble a matrix that allows multiple interfaces among different transmission standards. It is not useful to identify the large number of transmission systems that will need to interconnect, but dozens will need to be accommodated if a truly open telecommunications network is to occur.[10]

Economics

The power of economics must never be underestimated. Breakthroughs in identifying new applications, perfecting new technology, and agreeing on new technical standards are not enough to ensure the success of telecommunications equipment or services. The economic benefit must also be established. This means you must be able to do something more quickly, better, with greater security, and with more reliability—while also saving money—than you did before. In fact, the challenge is greater than that. The application of benefit/cost and net present value analyses to new projects suggests that the "benefits" of any such innovations must be able to pay back their research and development costs with room to spare for profitability. Also, the benefit/cost analysis needs to show a major advantage for the candidate technology over all other potential developments. A cellular mobile telephone system based upon time division multiple access technology that shows a three-to-two benefit/cost advantage over an analog system may seem attractive. Another option that uses code-division multiple access technology with a four-to-one advantage will prove to be the better choice.

Economics are not always straightforward or easily quantified. In today's complicated world of buying and selling telecommunications equipment and services, some of the so-called extraneous factors can become crucial. If a vendor can offer interest-free or below-market-rate loans, or "free" training, or subsidized maintenance and repair, then cost comparison of different vendors offerings can become nonlinear.

In fact, the traditional economic concepts of telecommunications are today largely obsolete. The ideas of monopoly economics and econ-

omies of scale, scope, technology, and density are becoming outdated and in some cases archaic. The idea of niche markets being able to emerge in almost any large telecommunications market is considered today's predominant economic paradigm. The major unresolved issue is whether the main thrust in creating improved market economies comes from engendering competition in value-added products and services, or whether major, capital-intensive telecommunications facilities must also be highly competitive with major players involved at all levels.

Japan and the United Kingdom (until recently) have championed "limited" competition for major telecommunications facilities and intensive competition for the value-added services. The United States has backed the wide-open melee and has ended up with both lower prices and a chaotic market structure confusing to most customers. Certainly price is the prime basis upon which most products and services are judged, and competitive commercial practices along with technology are keeping prices down. The question remains: Are the U.S. results primarily the outcome of good regulatory and competitive policy, or simply the lucky result of a huge telecommunications network?

A final related issue is that of capital financing in the world financial markets. Most of the major international and regional banks, such as the International Bank for Reconstruction and Development (IBRD, more commonly known as the World Bank) and the Asian Development Bank, have very strict guidelines that limit loans for telecommunications development to very rural and remote projects where there is less than one telephone per hundred. These "official" intergovernmental banks devote only about 2½ to 4 percent of their loans to telecommunications despite the fact that telecommunications has proven critical to overall development. The logic is simple. Commercial monies will be available for telecommunications because it produces revenues, which schools or roads do not. Efforts to relax these stringent rules on telecommunications financing during the 1980s were unsuccessful, but the move to deregulate telecommunications and make it competitive has sharply increased opportunities for international joint ventures and for forming new partnerships around the world. Cellular telephone systems in Eastern Europe and South America, satellite systems in Asia and South America, and vehicular satellite networks in Africa are all specific results of such new flexible commercial arrangements.[11]

Regulatory Policy

The patterns of technology, applications, and economics have characteristics that allow a certain amount of reasonable trend evaluation and even forecasting. The two parts of the model which are most difficult to anticipate are standards making and regulatory policy. This is largely because these two functions are driven most strongly by political considerations rather than by market or "objective" factors. For decades the mainline concept in regulatory policy for telecommunications was in favor of a monopoly which was thought to achieve economies of scale, scope, technology, and density. It was also presumed that this could best guarantee that rural and remote areas would eventually obtain universal service. This policy usually implied the need for a "small" subsidy to the rural area that would be provided by business and urban users. In the aftermath of the deregulatory tidal wave that swept the nations of the OECD in the last decade, the regulatory framework has changed greatly. Today an increasing number of nations are moving to break up privatized monopolies and to let market competition be the arbiter of service and tariffs.

The results to date have been startling. At least 40 countries on all five continents, including both developed and developing nations, have invoked some combination of privatization, competition, and deregulation. This has served to move telecommunications from a state or private monopoly to a competitively provided industrial service. Sometimes the shifts have been sweeping and sudden, such as in New Zealand, and other times they have been more modest and deliberate. Sri Lanka, for instance, has only allowed for limited competition in the form of a private cellular system. The vectors of change, however, are strong and are accelerating in scope and size. Particularly since rural and remote areas do not seem to have necessarily been hurt by privatization and competition, the move toward change in developing countries has increased in scope in the last three years.[12]

Finally, in some countries, patterns of corruption and vested interest can still be the largest barriers to change. It is a little early to tell whether competition and deregulation due to import of outside capital and differing forms of management techniques will have an effect on the corruption factor.

Only the extremely naive would believe that competition is able to substitute for all forms of regulation. Some degree of regulatory

adjustment and oversight is clearly needed. Regulatory agencies like the Federal Communications Commission (FCC), which were created out of national legislation that dates from 1927 and 1934 and represents the thinking of the New Deal, are not optimized to the new age of telecommunications in the 1990s. The United Kingdom, in creating its new Office of Telecommunications (OFTEL) within the Department of Trade and Industry, and its Australian counterpart AUSTEL, seem more in tune with today's regulatory concepts. They see their mission as "macro-managing" telecommunications service, eliminating major abuses of competitive practice, and limiting malfeasance. They do not see their mission as "micro-managing" tariffs and services. It is unclear whether the FCC and the public utilities commissions in the United States, with their historical role of overseeing tariffs and accounting procedures, can adapt to such a synoptic oversight role.

Many, but certainly not all, believe that the much more focused role of an OFTEL or an AUSTEL with a small and highly competent staff may be the best model for regulatory agencies of the 1990s. Clearly the heavy machinery of the U.S. government in the field of telecommunications distributed among more than a dozen agencies is an awful lot of bureaucracy for a deregulated industry to bear. This machinery comprises the FCC; the National Telecommunications and Information Administration (NTIA), NIST, and the Office of Trade Administration (OTA)—all within the Department of Commerce; the Department of Defense; the Department of State; and the Department of Education. It does not even end there. The Office of Emergency Preparedness, the Defense Communications Agency, the National Security Agency, the Defense Advanced Research Projects Agency, the various intelligence agencies, and NASA all participate from their perspectives too.

No issue is entirely one-dimensional, however, and deregulation is no exception. If indeed the future of telecommunications is to evolve toward universal digital standards and if total "open architectures" are to evolve, then some governmental mechanisms will be needed to help facilitate this result. In Europe, for instance, the European Technical Standards Institute (ETSI) and CEPT, and to some extent the European Telecommunications Satellite Organization (EUTELSAT), can all be effective in achieving a common understanding and a common approach. Japan's national standards institute can also help play this role, while the Asia-Pacific Telecommunity can aid on a regional basis.

ANSI, which is dominated by commercial organizations, may have greater difficulty undertaking this role for the United States. One way around this is to create a very small unit within the U.S. government and to charge it with regulatory review matters in the form of a watchdog function. This new agency would replace existing regulatory mechanisms. In addition, another small group should be created to deal with issues of national strategic interest with respect to trade and technical standards. In both cases the leverage or effectiveness of these units would stem from their small size, their exceptionally well-qualified staff, and their high-level location. Both agencies would have clout.[13]

Market Characteristics and Conditions

It is here that all of the pieces start coming together. This is because the projected market outcomes of our model are built largely upon the previous five factors of applications, technologies, standards, economics, and regulatory policies. The purpose of the heuristic model being developed in this article is thus to aid in analyzing possible future directions in the telecommunications market on a global scale.

It is hoped that with such insights established it may be possible to project when or whether a universal global telecommunications network might come into being. More to the point, we may begin to see the incentives and the barriers associated with making it happen.

The key to understanding markets is ultimately related to their size, the degree of their control by governments, cartels, or other such influences, and the extent to which they are free enough and flexible enough to allow rapid and major innovation. The issue of market size is critical. The move from local to regional to national to global markets is one of the most significant trends of our times. The dynamics that move markets in the direction of "global reach" are more complicated than it may first appear. First of all, the impetus in the past has related to products and goods much more than to services. Many services can be effectively provided in a local market, but products, especially high technology products like telecommunications and computer equipment, need to be offered in very large markets. This need for a global market relates to high volume, low profit margin, and low-cost production whose economies are scaled to millions of units. This is the obvious part. The truth is that global marketing and advertising, global distribution, and global repair, maintenance, and service networks may be even

more important. In short, in considering market characteristics, complexity, and size, it is crucial to consider not only the basic differences between services and products, but also how they are more and more intertwined. Nevertheless, differences still exist at all levels: design, production, sales, distribution, and repair and maintenance.

The next critical factor as it relates to markets is the extent to which they are controlled. Control can come in many forms. There can be direct government control in terms of regulating prices, wages, and supply. Government control can be less rigid in terms of setting quotas, ceilings, or guidelines. Also, subsidies or tax credits may be set to provide assistance to some disadvantaged group such as rural or remote populations. Sometimes the credits aim to promote a particular line of behavior, say, to use mass transit and increase energy conservation. In such cases, subsidies can sometimes go to the affluent. Finally, there are the informal processes that are often overlooked or at least not discussed. These are at the *sub rosa* level of government corruption, where illicit payments serve to arbitrarily distort the market, providing individuals or corporations advantage.

Markets can also be altered and distorted by collusion among the market suppliers and, in much more rare circumstances, by dominant purchasers. In both of these cases it is more likely to be a coalition or cartel of suppliers or purchasers that conspires to set prices above or below the normal market rate. As we move to a global marketplace with world-class suppliers, the problem of "dumping" low-cost products in targeted national markets to drive out competition and establish market dominance will remain an issue. The current trend to create regional mega-markets, such as the European trading community in 1992 and the U.S./Canada/Mexico North American market, will likely serve to accentuate this problem. It seems likely that this will lead to increasingly bitter and ruthless trade wars among the most cost-efficient and technologically sophisticated global corporations or, alternatively, more and more trading partnership across the regional trading coalition. Instead of the United States and Japan debating who is number one, we might see instead a growing number of joint licensing agreements, joint marketing agreements, and cross-ownership and cross-patenting pacts. If, for instance, a new Asia-Pacific coalition of Japan, Canada, the United States, and the other newly industrializing countries of the region were to create a trading coalition, it would represent nearly a

$9 trillion trading pool in contrast to Europe's $5.5 trillion (see Tables 1 and 2). Furthermore, it would represent more than 70 percent of the world's advanced technical patents, computers, and robotic devices. This suggests that we will have increasingly difficult market competition on a global scale for some years to come, and that regional mega-market coalitions could serve to ameliorate or at least rechannel the global high tech trade wars. This is significant in that it seems hard to forecast a globally universal digital network with unified standards until the trade wars issues are resolved.

The final aspect of the market to be understood is that of freedom and flexibility to implement rapid innovation. The so-called Western countries of the OECD have relatively free and open markets that have

Table 1 The Hypothetical Japan/Canada/U.S. Alliance

Countries of the Japan/Canada/U.S. Alliance	*Population (Millions)*	*GNP in U.S. Dollars*
Japan	125.0	$3,000 billion
Hong Kong	7.0	95 billion
Republic of Korea	48.0	250 billion
Singapore	3.0	60 billion
Taiwan	22.5	130 billion
Canada	28.0	400 billion
United States	250.0	5,000 billion
Totals	483.5	$8,925 billion

Table 2 The European Community Alliance

Countries of the European Community	*Population (Millions)*	*GNP in U.S. Dollars*
Belgium	10.5	$ 105 billion
Denmark	5.8	65 billion
France	62.0	1,300 billion
Germany	65.0	1,400 billion
Italy	64.0	550 billion
Luxembourg	.5	5 billion
Netherlands	18.0	230 billion
Portugal	11.5	28 billion
Spain	44.0	250 billion
Sweden	9.5	130 billion
Switzerland	7.5	150 billion
United Kingdom	60.0	900 billion
Totals	358.3	$5,113 billion

let incredibly rapid breakthroughs occur in telecommunications, computers, artificial intelligence, and other areas. The key indicators of market openness to innovation include the ease of entry by start-up firms, the ability for inventors to obtain patents and rights, the availability of venture capital to support new concepts, and the existence of disincentives for monopolies or dominant firms seeking to retard or limit new innovations in the marketplace. The most difficult issue in this regard is when a country seeks to protect local markets by limiting innovations and competition through technical barriers, standards, tariffs, and non-tariff barriers, such as mandatory testing programs or trade quotas.[14]

SECTION 3
A DETAILED ANALYTIC MODEL OF THE TELECOMMUNICATIONS ENVIRONMENT AND AN ASSESSMENT OF THE COMING UNIVERSAL GLOBAL NETWORK

The basic ingredients of an analytic model of the world telecommunications environment have been discussed in some detail in the previous section. Figure 1, on pages 150 and 151, which provides the schemata of the model, its basic dimensions, and the subsets of each of its major factors, should at one level be self-explanatory. The most important feature of the model is that it is simply a tool to understand the process of change in the various parts of the world telecommunications environment. The model helps in systematically making judgements as to whether changes in technology, applications and services (i.e., the market), standards, economics, and regulation will accelerate toward a universal global telecommunications network, or whether greater barriers and inertia will be encountered.

This model of the telecommunications environment can be used not only to assess progress toward a universal network, but also as a normative or strategic planning tool. This is a great challenge today, because early evolutionary steps toward a universal global telecommunications network are just beginning. The basic problem seems primarily a lack of economic, social, and political push toward such a universal system based upon broad-based need. The advocates are in effect trying to pull the concept forward without sufficient market support. With the pos-

sible exception of large telecommunications vendors, there are no large organizations which view the creation of such a network to be of overriding commercial or financial interest at this time. While many people and organizations see the potential of creating a universal network sometime in the future, the perception is that "others" will make it happen. They perceive that any expenditure of their scarce resources will create personal hardship while ultimately giving advantage to existing or future competitors. The creation of a universal network can thus be seen in the context of gaming theory, where the current situation is a classic "zero-sum" game. Until a realistic and practical way can be found to show how the creation of such a network can translate into a "win-win" situation, a successful macro strategy will likely be retarded. Even with gains in technology, applications and services, and economics, it seems unlikely that critical progress in standards and regulation can be made until this key issue is resolved.

Certainly one of key functions of the model will be to identify the critical paths forward and the major barriers. The model in Figure 1 should be seen as no more than a crude attempt to diagram today's telecommunications environment and how it could lead to the creation of a universal digital network, combining private and public telecommunications systems so as to actively support all of the world's largest users. An analysis of the model suggests that the market, standards, and regulatory issues are currently the major barriers to implementation, while technology is the main incentive. Economics meanwhile seem to be oscillating in the middle. Table 3 reflects the positive and negative forces at work on the key factors in the model.

In analyzing these, certain key issues should be noted. There must be a special focus on how to interconnect private and public networks. This implies that allowance must be made for "specialized service networks" rather than insisting on totally integrated digital services. Developing countries must have the right to make extended transitions out of analog services. A variety of transmission media including fiber optic cable, twisted pair and coax, satellite communications, cellular radio, and even infrared must be allowed to be a part of a universal global telecommunications network through universally open standards. This means that every aspect of standards—quality, error control, flow control, system availability, security, transmission delay—must be designed to include rather than exclude.

Table 3 Factors Affecting the Creation of a Universal Digital Network

POSITIVE INCENTIVES

- Universally available open systems with a common interface would constitute a global asset.
- Multi-media services available upon demand through a single integrated network provide potential new economies.
- Transparent connection to all countries is a political advantage in terms of peace keeping and open communications.
- Access to a broad range of services through an "intelligent network" offers new economic and market opportunities.
- Rapid evolution of telecommunications technology may aid a universal network. (Examples include soliton pulse fiber-optic cables, satellites with on-board processing, enhanced chip memory, "intelligent" buffers, algorithms, and advanced signalling.)
- A universal global telecommunications network should enhance performance in terms of security, quality (e.g., bit error rate), and system availability.
- It could allow for effective interlinking of ISDN networks and private digital networks (e.g., LANS, MANS, and WANS). It could also allow for better interconnectivity of the public switched network, switched megabit digital service (SMDS), synchronous optical network (SONET), asynchronous transfer mode (ATM), and fiber distributed digital interface (FDDI).
- It could allow for multiple standards solutions at the level of effective interface rather than just a single universal standard.

NEGATIVE FACTORS

- It could involve tremendously high costs of network implementation, especially if fiber optic cable to the home and small business is involved.
- There are tremendously large write-offs or sunk costs in existing telecommunications equipment. (This will be a special problem in developing countries.)
- There are still major difficulties in reaching clear-cut and timely new standards in broadband digital services. This will be coupled with the inadequacies of ISDN and a lack of appreciation of how private networks will need to be accommodated in new digital standards.
- There is currently a lack of market support for the creation of a seamless universal network.
- There is not a clear statement of the social and cultural advantages that will come from a universal global telecommunications digital network.
- There are strong alternate views that separately optimized networks for specific services such as voice, data, video, and imaging will produce better performance, quality, and cost efficiency.
- National trade objectives may serve to retard or prevent the creation of a universal global telecommunications digital network since it tends to create a seamless and barrier-free world economy.
- Conflicting values and political priorities may dictate that capital investments go to other targeted objectives.

In this respect there is a good model: ISDN. In this case the model is one to be avoided rather than copied. When ISDN was first conceived in the 1970s by AT&T and the Bundespost, the idea was basically to try to create a uniform and totally integrated system. It clearly had technical merit, but it also implied continuation of a system of interconnected monopoly telecommunications organizations. The standards-making process that ensued was slow, deliberate, and focused on answering telecommunications questions that the monopoly organizations had defined as key rather than those that the marketplace had raised. It is thus not surprising that ISDN has had little customer push and mainly vendor- and carrier-related pull. If one is to seek a positive model for a universal network, then the FCC's effort to create what it has called open network architecture (ONA) is perhaps a useful place to look. Now may be the time to look beyond the rather confining concepts of ISDN and even broadband ISDN and to begin to explore concepts like universal digital services.[15]

This new initiative would certainly have its share of problems. One of the most critical would be how to approach the world's standards-making entities, particularly the ITU. The ITU has devoted nearly two decades to ISDN and cannot easily toss these efforts aside. Clearly what is needed is leadership. In the best of all possible worlds this would come from both inside the ITU framework and from telecommunications leaders in the commercial sector.

It is important to justify the development of a universal digital network on more than economic grounds. The social and cultural implications also must be understood. This means that the negative social aspects of a universal digital network need to be identified, and means of mitigating these "teleshock" impacts should be developed. Such aspects as privacy; information overload; telework-based electronic sweatshops, especially for child laborers; and electronic surveillance must be addressed. In addition are potential problems with electronic desk-killing and technological unemployment, super-speed living, the 168-hour work week, electronic alienation of society, and the increasing homogenization of global culture and languages. These issues need to be considered by a global collaboration of social scientists, legislators, economists, and business people.

The universal global telecommunications network is an extremely powerful idea which is likely to be in place sometime relatively early in

the 21st century. As we move toward this global electronic village and perhaps beyond it, there are many key points to be considered. The universal global telecommunications network will not be as monolithic and one-dimensional as the early concept of ISDN. It will allow for multiple networks including both public switched and private networks. It will include fiber and satellites and radio and even infrared. It will pay much greater heed to social and cultural goals in its design and implementation as Nippon Telegraph & Telephone of Japan did with its original concepts of the integrated services network (ISN). This leads us to the overall conclusions of this study.

CONCLUSIONS

What is a universal global telecommunications network and when will it become a reality? Intentionally a rather broad and vague operational definition has been used up to this point to accommodate the most diverse range of ideas. To conclude, however, we must have in mind a much more precise idea of this network than a kind of super-ISDN that enshrouds the globe.

The universal global telecommunications network will serve as the main opto-electronic and electronic telecommunications conduit for economic, social, cultural, and political exchange among the peoples of planet Earth in the 21st century. This network, unlike that conceived for ISDN, is not monolithic. It will feature agnostic interfaces with private and public networks. It will also support integrated service networks and service-specific networks. If designed properly, it will accept any "interface and interconnection" of choice within plausible reason. It will support everything from asynchronous transfer mode and cell relay to X.25 data relay or analog voice or video. In its early implementation, this network may start to come into place around the second decade of the 21st century. This global network would likely be available in every major city in every OECD country at speeds that range from 45 megabits/second (DS-3) to 2.5 gigabits/second (OC-48).

Technically, the biggest problems will be supporting multiple interfaces and universal error control systems, and dealing with satellite and other processing delays. Some form of the universal global telecommunications network will be found in newly industrializing countries and

developing countries, though often limited at least in developing countries to the capital city and perhaps two or three other industrial cities. One implication of this network is that it will link the most economically and technically powerful together in new and ever more effective ways. Denver, Colorado, will be more effectively linked to London, England, than to Okmulgee, Oklahoma. Yaounde, Cameroon, although only a few hundred kilometers away from Akom, will still be electronically closer to Paris, France. The first phase of the network will unfortunately not be universal. Universality is still some time away. The advent of the Motorola Iridium low-orbit satellite system or the U.S.S.R.-backed Small Sat System may, however, constitute the unexpected extension of this global network, providing seamless and universal coverage sooner than many would expect to the world's most remote areas.

Who provides this global network? Today we know it will hinge on more than the leading public telecommunications monopolies. Lots and lots of people and organizations are involved and this will make the technical design and implementation more difficult and more challenging, but ultimately more extensive and rewarding. Capital financing, richness of service offerings, and innovative telecommunications concepts under this more open approach are likely to be enhanced.

How do all of the standards issues get resolved? This is a very big problem for at least two reasons. First, all of the national and regional standards bodies are still likely to get in the way of global agreements even if the agreement allows for diversity of approach. Diversity will help, but it will not necessarily solve the problem. Second, the key player in all this is still the ITU. In a number of ways, unfortunately, the ITU is not well suited to its task. Problems include:

- *Bureaucracy.* The ITU's permanent staff and its standing committee membership within the Consultative Committee for International Radio Communication (CCIR) and the Consultative Committee for International Telegraph and Telephone (CCITT) are in need of fresh ideas, new people, and streamlining.

- *Adjustments to the Times.* The shift to competition, deregulation, and privatization was not effectively reflected in the ITU's latest Plenipotentiary Conference held in Nice, France, in 1988. The idea that the division between the CCITT and CCIR may create more

problems than it solves was swept aside with modest debate. The fact is that in a competitive environment a new approach to standards making might be essential.

- *New Standards.* In terms of speed of development, coordination with other standards groups, conformance testing, and application development, there is good reason to doubt that the ITU is currently equipped for effective telecommunications standards making for the 21st century. This is not to suggest that the other standards-making organizations around the world do not also have problems, but the warts and wrinkles on the ITU are perhaps the most notable and severe.

The results of this paper suggest that a universal global telecommunications digital network is a desirable goal and that it can be reasonably accomplished in its initial form in about 20 years. There are, however, a significant number of planning activities to be undertaken as soon as possible to make this happen. Certainly a number of major barriers which have been identified must be overcome if such an initiative is to succeed. International coordination and concerted global action will be needed if the forecast 20 years until implementation is to prove accurate. The specific areas of action are as follows:

- *Obtain Policy Consensus.* A broad global consensus needs to be developed to support the creation of a universal global telecommunications network. A positive rationale and an action plan need to be created to explain how such a global network can be a positive force for world development and can benefit developed and developing countries alike.

- *Prepare a Universal Global Telecommunications Network Impact Statement.* In order to build the needed policy consensus, a widespread series of studies needs to be undertaken by foundations, governments, and institutions that represent a broad coalition of countries and which enjoy a broad basis of intellectual, social, cultural, and legal respect. These studies would examine the positive and negative impact of such a network and, especially, would seek to identify ways that negative impacts could be minimized or eliminated.

- *Reform Standards-making Processes.* There is a need, in fact a rather urgent need, to revamp the standards-making procedures of the ITU, and to a lesser extent the ISO, the IEC, ETSI, ANSI, and the Telecommunications Technology Committee of Japan. Key reform elements would focus on how to achieve more effective interfaces between public and private networks and between telecommunications and data networks. Also, this activity should seek to make processes more representative of today's deregulated world, more streamlined and quicker, and more dependent upon ongoing field trial and conformance testing. Pragmatism, rather than new theoretical concepts, is needed.

- *Streamline and Modernize the ITU.* In addition to improving the processes of standards making, there seems to be a particular need to reorganize the ITU and in effect to make it less bureaucratic. Downsizing of staff, clear objectives and focus, automation, streamlining of study groups, and combining the CCIR and CCITT would be good places to start.

- *Include the International Trade Community.* There is a need to develop a clear understanding and relationship with the international trade community concerning the new network, because it has the largest vested interest in having such a network created. The direct relationship between increasing global trade and a universal global telecommunications network is larger than shipping, air travel, or any other single service industry.

- *Create a Better Understanding of a Universal Global Telecommunications Network.* There is a need to create among politicians, statesmen, technologists, business people, economists, educators, and economists a better understanding of what such a network would be, how much it would cost, and why it is needed. This might be done by creating a detailed and clear model of how the network would come to be. We also need to know clearly the functions of the network in a global marketplace. Developed countries, newly industrializing countries, and developing countries should be able to see within the model how they would benefit. All the other key players should be able to do likewise.

- *Discover the Market Push.* All of the above activities should contribute to a better understanding of why the global user community described in the model would wish to support the creation of a universal network. Unless this basic motivation is found, the result will be much like that associated with ISDN implementation. Technological pull is not sufficient to stimulate new telecommunications investment that could grow into the trillions of dollars. Enhanced trade, international business, more effective operation of the global job market, time shifting, and peak load spreading are only a few of the potential reasons for creation of such a new network. Leveraging the combined strengths of public and private telecommunications networks could also be key. The important step is to recognize that such a new voyage of discovery is needed and that a broad spectrum of countries, government officials, and industrialists must take it together.[16]

Today, it is hard to look forward two decades into the future and say exactly when the first real stages of the universal global telecommunications network will be in place. The important thing is to begin to take intelligent and thoughtful steps now. The invention of the future is an exciting activity that is largely unique to modern times. The creation of a truly interconnected planet that provides economic, technical, cultural, and social services with ease and grace—not to mention political enlightenment—could be the unique accomplishment of humankind in the 21st century.

Today, we humans, some 5.2 billion of us, inhabit a six-sextillion-ton planet which will grow in population to perhaps 10 to 12 billion people. Our global information base, however, will continue to expand exponentially. Since the time of ancient Greece, human population has increased some 50 times while our global information base has expanded 10 million times. If this trend continues we may find we are overwhelmed with information in the next century. This means we will need more "smart tools" to store and retrieve information too copious to remember and store inside our brains. It means that electronic and optical communications systems will become more like extended neural networks of our brains. It suggests that a universal digital network and capabilities may come into being in the 21st century simply because we cannot sustain modern life without such intelligent grids

aiding us to attain new states of knowledge and global awareness. Such problems as the "informatization" of society will no longer be distant and remote concepts, but will become the real world dilemmas of humankind in the 21st century.

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ATTACHMENT 1
A COMPREHENSIVE LISTING OF CURRENT DIGITAL TELECOMMUNICATIONS SERVICES, APPLICATIONS, AND FEATURES

A. VOICE CAPABILITIES

1. Voice Transmission

Voice/data transmission
Multi-button phone sets
ISDN interface to cellular/mobile radio and satellite
Voice/data key system
Multiple computer access

2. Call Management

Continuity of basic service during CPE power interruption
Passive bus
Autovon features on ISDN switches (priority access)
Automatic number ID
International call completion utilizing the higher-level compatibility information element (HLCIE)
Distributed reservation processing
End-user addressing
Directory number screening
Customer inquiry handling
Primary rate interface to airline ACD equipment
Ringdown using fast-call setup
Call manager

3. Message Services

Interface to voice messaging systems
Message desk
Transparent networking of voice messaging systems

4. Answering Services

Sales information management
Intelligent secondary answering
Automatic callback for financial services
Centralized voice mail

Unified message status notification mechanisms
Call park
Transparent fistribution of incoming call to a single ISDN number
Enhanced 911 signalling
Data base information to corporate security

B. DATA CAPABILITIES

1. Data

Small business EDI access
Personal computer wide-area networking
Single update for multiple administrative data bases
Multi-point screen sharing
X.25 PAD support
High-speed file exchange
Coax elimination
Asynchronous protocol conversion to SNA/SDLC
327X emulation via SIM-PC, SIM-VTAM and NPSI
327X emulation with QLLC and NPSI
Asynchronous access to UNIX host
Asynchronous access to UNLY host via PAD and X.25
PC/mainframe connectivity
ISDN access to geographically remote locations
Airline data base transfer via ISDN
ISDN telephone as a data I/O Device
Facsimile
ISDN data gateway

2. Modems

Switch-based modem pool
Asynchronous access to host computer

3. LANs/WANs/MANs

Remote terminal access to LANs
Remote terminal simultaneous access to multiple hosts
MAP 3.0 interface to WAN
ISDN value-added services
Multi-point permanent data circuits

C. VIDEO/IMAGING CAPABILITIES

1. Video
On-demand video
Circuit-switched compressed video

2. Graphics
Variable bandwidth for voice/imaging communications
Data conferencing/EDI
Teleradiology

D. NETWORK SERVICES CAPABILITIES

1. Management
Automatic recovery/re-establishment of voice call
Network service negotiation
Virtual networking
ISDN virtual private network using channel switching
ISDN subrate multiplexing
Dynamic customer control
Multi-media services (ISDN user-network management services)
Services availability
Centralized CPETSS configuration/software management
Remote network management
MIS capabilities with ISDN
ISDN TA monitor connection for diagnostic purposes
Remote network management of terminal adaptors

2. Interconnect
Two-wire "U" interface capability
ISDN and GOSIP compatibility
Inter-subnetwork services end-to-end integrity
Combined SNA/ISDN session setup
ISDN interplay with DTMF units
Adjunct processor interface
EtherNet LAN bridging

3. Security
Secure network services
Security control for "super-user" access
Secure ISDN terminal
BRI encryption device

E. MULTIMEDIA CAPABILITIES

1. Telecommuting
Telecommuting

2. Teleconferencing
Video teleconferencing
Guest service center

F. OTHER CAPABILITIES

Building control via ISDN facilities
ISDN switch conformance
ISDN interoperability (portability at BRI/PRI)
Engineering workstation interface to ISDN
ISDN for point-of-sale (POS) or point-of-banking (POB)
ISDN financial evaluation process/model
Universal station message detail recording (SMDR)
ISDN telephone/ISDN workstation integration
Premise wire distribution
ISDN deployment schedule
Loopback testing
Optional calling ID insertion on call origination
Transparent outbound service selection
Use of existing secure terminal over ISDN

Note: This listing of ISDN capabilities was prepared for the U.S. National Aeronautics and Space Administration under Grant NAGW-1105 by the Interdisciplinary Telecommunications Program at the University of Colorado. For the complete report contact the ITP Program at the University of Colorado.

COMPREHENSIVE LISTING OF OFFERED AND PROPOSED ISDN CAPABILITIES

Some of the capabilities offered or proposed have different titles but describe similar functions.

1. Continuity of basic service during CPE power interruption
2. ISDN subrate multiplexing
3. ISDN switch conformance
4. Multimedia services (ISDN user-network services)
5. Virtual networking
6. ISDN virtual private network using channel switching
7. End-user addressing
8. Call alternate routing
9. Distributed reservation processing
10. Hotel guest service center
11. Security control of super-user access
12. Telecommuting
13. ISDN for point-of-sale and point-of-banking
14. Sales information management
15. Engineering workstation interface
16. Manufacturing "just-in-time" application using MAP/TOP
17. Data conferencing/EDI
18. Corporate data base security based on CLID
19. ISDN WAN transport services
20. On-demand video
21. Terminal portability
22. Secure ISDN terminals
23. Secure network services
24. Switch-based modem pooling
25. Directory number screening
26. Small business EDI access
27. International call completion utilizing HLCIE
28. Universal station message detail recording
29. Automatic recovery/reestablishment of voice call
30. Remote terminal simultaneous access to multiple hosts
31. ISDN interface to cellular/mobile radio and satellite
32. Building control via ISDN facilities

33. Dynamic bandwidth negotiation
34. LAN access via remote terminal
35. Intelligent secondary answering
36. Network service negotiation
37. Transparent networking of voice messaging systems
38. Single update for multiple administrative systems
39. Interface to voice messaging systems
40. X.25 PAD support
41. High-speed file transfer
42. New account customer handling
43. Cost recovery modeling (resubmitted as ISDN cost modeling)
44. ISDN cost modeling
45. ISDN interoperability at primary rate
46. Dynamic customer control
47. Passive bus (multi-point BRI)
48. Multi-point screen sharing
49. Video teleconferencing
50. Audio-videotext
51. Remote inquiry (TV quality, image-per-view and sound sequence enquiries)
52. Remote image monitoring
53. Automatic banking
54. Enhanced voice messaging
55. Automatic number identification
56. Tele-radiology
57. Multiple computer access
58. Coax elimination
59. Personal computer WAN
60. Facsimile
61. Tele-marketing
62. PC networking
63. PC local/wide area networking
64. PC/mainframe connectivity
65. General packet connectivity
66. SNA networking and circuit-switched connectivity
67. Desk-to-desk conferencing
68. Joint preparation and editing of documents
69. Consultation between two parties

70. Training on PC applications
71. Exchange of voice and data between remote locations
72. Call manager
73. Personal directory
74. Telephone log/call management
75. Application dialing (user can dial directly from PC)
76. Automatic callback
77. Message desk (PC-based answering)
78. Interoffice conference
79. Real estate agent/lender communications (voice/data)
80. Customer service
81. Service dispatching/help desk
82. Field office support using FAX IV
83. ISDN applications for the home (telecommuting)
84. Encrypted and secure communication in ISDN
85. Multimedia communication services
86. Asynchronous protocol conversion to SNA/SDLC
87. VTAM internodal network link replacement
88. Remote 3174 multiplexing via B channel packet
89. Remote 3174 multiplexing via B channel packet and network packet switched interface (NPSI)
90. 327X emulation via SIM-PC, SIM-VTAM, and NPIS
91. 327X emulation with QLLC and NPSI
92. Asychronous access to private packet switched network
93. Asychronous access to UNIX host
94. Asychronous access to UNIX host via PAD and X.25 multiplexing
95. 327X coaxial cable elimination
96. Extended LAN with passive bus
97. Asynchronous access to EtherNet terminal server
98. Dedicated-line replacement
99. Asynchronous modem pooling (outdial)
100. Asynchronous modem pooling (indial)
101. ISDN wide area networking
102. ISDN data gateway
103. Gateway to AppleTalk network
104. Application processor features circuit switched compressed video
105. Circuit switched compressed video

106. Ethernet LAN bridging
107. PC-PC/mainframe
108. Shared screen
109. Access to multiple PC hosts via X.25/mainframe host
110. LAN/ISDN interworking
111. Host-to-host
112. Elimination of 3270 coax connections
113. Mainframe redundancy
114. Modem pooling
115. Slow-scan and full-motion video
116. Attendant services
117. Multi-button phone sets
118. Applications processor services
119. Electronic directory
120. Message service
121. Traffic analysis
122. Station message detail recorder
123. Facilities/asset management

Note: This listing of the capabilities used in this study was compiled from the following sources: North American ISDN Users Forum, November 14, 1989, US West, Northern Telecom, AT&T, and Southwestern Bell.